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CAMBRIDGE, MASS. FEBRUARY 8, 1952 NUMBER 1

A NEW PANAMANIAN TREE FROG

BY EDWARD H. TAYLOR

Department of Zoology, University of Kansas, Lawrence, Kansas

While studying Central American frogs in the Museum of Comparative Zoology, Harvard College, a small, presumably undescribed frog was noted, and Mr. Arthur Loveridge, with his characteristic kindness, suggested that I study the form and describe it if it proved new. The most characteristic of the differential features of this diminutive frog is the very considerable enlargement of the horny spines on the nuptial swelling of the first finger. It is presumed that it is a rivulet species, living in the neighborhood of small streams, rather than a bromeliad species.

After my study of the specimen and comparison with other known species of southern Central America, I conclude that the species is new and I present herewith its description.

HYLA SHREVEI sp. nov.

Type. M.C.Z. No. 26769 ♂. La Loma, Chiriquicito, República de Panamá; E. R. Dunn and C. Duryea, collectors.

Diagnosis. A diminutive frog (25.2 mm.) with a broad, rather flat head; skin smooth; outer fingers with a trace of web, and well-developed discs; canthus rostralis wanting; nostrils nearly terminal; tympanum large directed strongly upward, its diameter at least half of eye length;

eye directed obliquely forward; vomerine teeth in two rounded fasciculi, lying almost completely behind posterior level of large choanae; no web between two inner toes; others one third, to one half webbed; first finger of male with 19–22 large horny spines.

Description of the type. Head flattened, broader than body, its width (10 mm.) greater than its length (9.1 mm.); tympanum large, semitransparent, pigmented, facing more upward than outward, the upper edge obscured by a fold arising at eye and curving back to jaw angle, its diameter (1.5 mm.) equal to half length of eye opening (3 mm.); distance between tympanum and eye 2.8 mm.; eye prominent, directed somewhat forward; length of snout less than eye length (2.85 mm.); canthus absent, loreal region concave, sloping obliquely to lip; nostrils nearly terminal, the areas about them strongly swollen with a depression between; no notch in upper lip; groove from angle of jaw touches tympanum; choanae subcircular, the distance between them 2 mm.; diameter (transverse) of choana .65 mm.; vomerine teeth in two somewhat circular fasciculi almost completely behind the posterior level of choanae, the teeth in somewhat curving rows; they are equally separated from choanae and from each other, a fasciculus as large as a choana; tongue rather thick, broader than long, not or scarcely notched behind; vocal slits very large, lateral; openings of the palatal gland forming a series of separate slitlike openings arranged in a broad V-shape about the middle of palate.

Arm very short, the wrist not reaching tip of snout; first finger short, greatly expanded at base by a very large nuptial swelling and a large metacarpal tubercle; swelling covered with a black, horny plate bearing 19–22 large horny spines; discs of fingers smaller than tympanum, that on first finger only little smaller than those on outer fingers; a small trace of webbing between outer fingers; subarticular tubercles single; supernumerary tubercles numerous; palmar tubercle partly divided; a slight axillary web present; heel reaches forward to edge of eye; tarsal fold represented by a series of tubercles growing more distinct on the proximal end of tarsus; a large inner metatarsal tubercle and a small distinct outer; no web between first and second toes; one fourth webbed between second and third; approximately half webbed between the third and fourth and two fifths webbed between the fourth and fifth, the web forming a slight ridge to discs on sides of digits; subarticular and supernumerary tubercle distinct. Skin on dorsum smooth, slightly wrinkled or corrugated on sides; chin smooth; breast, venter, part of the ventral surface of thighs and region lateral to vent, strongly granular; a rather elongate anal flap, the vent opening midway between upper and lower surface of thighs, followed

by a groove bordered by small granules and on ventral surface by a pair of distinctly larger granules; fold above tympanum curves down to jaw angle.

Color. In preservative, light brown above with a brownish-white shade below; the pigment is in minute chromatophores, that can be clearly seen under a lens; no pigmentation on under surfaces except on edge of jaw, under surface of thigh, part of under surface of tibia and some scattered flecks under hand and foot; upper eyelids appearing dark from the dark covering of the eyeball; tip of snout somewhat darker than dorsum.

Measurements in mm. Snout to vent 25.2; width of head 10; length of head 9.1; diameter of tympanum 1.5; length of eye opening 3; snout length 2.85; arm 13; hand 7.2; leg 38; tibia 12; foot and tarsus 15.

Remarks. The species is probably related to *Hyla zeteki*. There are numerous similarities in structure, and the measurements are similar but the most striking differences appear to be in the remarkable nuptial asperities on the first finger, the position and direction, and the larger size of the tympanum ($^1/_2$ instead of $^1/_3$ of eye); the absence of the spectacle-like markings about eyes. The characteristic anal decoration of *zeteki* is absent, and the strong granulation on under surface of arm, and on sides is absent.

The species is named for Mr. Benjamin Shreve of the Museum of Comparative Zoology, Harvard College.

Hyla shrevei sp. nov. M.C.Z. No. 26769, La Loma, Chiriquicito, República de Panamá. E. R. Dunn and C. Duryea, collectors. (Type ♂ X 2.) 1. Dorsal view. 2. Lateral view of head. 3. Enlargement of nuptial spines on inner digit.

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Museum of Comparative Zoology

CAMBRIDGE, MASS. FEBRUARY 8, 1952 NUMBER 2

A STAUROTYPINE SKULL FROM THE OLIGOCENE OF SOUTH DAKOTA

(Testudinata, Chelydridae)

BY ERNEST WILLIAMS

INTRODUCTION

The modern representatives of the Staurotypinae (two genera, *Staurotypus* and *Claudius*, and three described species) are restricted to Southern Mexico and Central America. No fossils belonging to these living genera are known. A form known only from a single perfect shell from the Oligocene (Chadron) of South Dakota, *Xenochelys formosa* Hay, seems to be the only previously described fossil record of this subfamily.

Recognition of a staurotypine from shell material as good as that of the unique type of *Xenochelys* (A.M.N.H. No. 1097) is quite easy. Staurotypines differ from chelydrines in having only 23 instead of 25 marginals and 21 rather than 23 peripherals. The same feature distinguishes them from dermatemydids. They differ from kinosternines in possessing an entoplastron. In these characters *Xenochelys* is clearly staurotypine. In the elongation of the first vertebral scute and in its precise shape *Xenochelys* closely resembles *Staurotypus*. The neural series is much as in *Staurotypus*. The plastron of *Xenochelys* has a reduced number of shields, the pectorals and abdominals having apparently fused. This again is a staurotypine or chelydrine feature. The general form and height of the shell are very *Staurotypus*-like. There is also some suggestion of the tricarinate condition found in *Staurotypus* in the carapace of *Xenochelys*.

In other respects the shell of *Xenochelys* is more primitive (more dermatemydid-like) than any other member of the chelydrid series. The plastron is relatively large (although the bridge is quite narrow as in chelydrids, not as in dermatemydids). There is a xiphiplastral notch. The nuchal scute is small. There is a trace of nuchal indentation.[1]

In shell characters, therefore, *Xenochelys* is a good structural intermediate between *Dermatemys* and *Staurotypus*, and it is also a temporal and phylogenetic intermediate between the complex of fossil forms called dermatemydid and the staurotypine section of the Recent Chelydridae.

It should be noted that Hay was not under any misapprehensions as to the affinities of *Xenochelys*. He quite explicitly cited *Staurotypus* and *Claudius* as "the nearest living relatives of *Xenochelys*" (1908, p. 282), and in his assignment of the form to the Dermatemydidae he merely followed Boulenger's 1889 catalog of the Recent turtles in which the Staurotypinae were associated with the Dermatemydidae. When he published his 1908 monograph he had probably not seen Siebenrock's 1907 monograph of the "Cinosternidae" in which the close affinities of the Staurotypinae and Kinosterninae were for the first time made clear; he thus missed an opportunity to point up more clearly the apparent ancestral position of the South Dakota genus.

In my 1950 classification of the testudinate order I united the chelydrines, staurotypines and kinosternines in the family Chelydridae as understood in a broad sense. To do so somewhat obscures the extreme closeness of relationship of staurotypines and kinosternines, which differ in the simultaneous loss of an entoplastron and acquisition of more or less of a box turtle habitus by the latter. The chelydrid series is surely a natural group, but within that group the staurotypines and kinosternines stand very much closer to one another than to the chelydrines.

In the Oligocene this specialized section of the Chelydridae *sensu lato* was evidently fully distinct in shell characters, if still somewhat primitive in a few features. It has, however, not previously been known to what extent the skull had evolved concomitantly with the shell.

In the collection of the Department of Geology, Princeton University, I have now found a skull (No. 13686), likewise from the Chadronian Oligocene of South Dakota, which surely belongs to a member of the staurotypine-kinosternine section of the Chelydridae. It is distinctly more specialized in a number of ways than any previ-

[1] Most of these characters might also be counted as kinosternine resemblances.

ously known staurotypine or kinosternine skull. Although incomplete it merits extended description and discussion. In the section which follows, the skull is described in detail and compared with *Claudius augustatus*, *Staurotypus salvinii*, and *Sternotherus carinatus*.

DESCRIPTION OF THE PRINCETON SKULL

The skull is complete as far as the postorbital bar. Behind this, however, only the parietals, pterygoids, basisphenoid and basioccipital are retained, all of them somewhat fragmented and incomplete. Sutures are rather difficult to make out because of fractures in critical areas.

The profile of the face is strikingly like that of *Staurotypus* or *Sternotherus*. The prefrontals project dorsally above the narial opening but laterally are somewhat retracted, so that in lateral view the nostril is seen as a distinct angular indentation. The premaxillae unite in the formation of a distinct median beak, while posterior to this median projection the contours of premaxilla and maxilla form a smoothly sinuous curve, which, however, is doubly incurved in the fossil in contrast to both *Staurotypus* and *Sternotherus*. The depth of the premaxilla is markedly greater than in *Staurotypus*. The orbit is relatively smaller than in *Staurotypus* and even more distinctly lateral (in contrast to dorsolateral) than in that form. The maxilla below the orbit is marked by a distinct groove running down to the second incurving of the lateral festooning of the jaw. The postorbital bar is rather wide, half the rostro-caudal length of the orbit rather than between $\frac{1}{3}$ and $\frac{1}{4}$ as in *Staurotypus*.

In lateral view the prootic is seen to project far forward about the pterygoid in a very exceptionally developed "crista praetemporalis" (Siebenrock 1897). Only a narrow channel separates these two bones. The dorsal margin of the prootic is continued also in a ridge on the parietal. A similar forward projection of prootic is seen in *Staurotypus* (and in *Graptemys*) but is far less extreme.

The "crista praetemporalis" which is the feature exaggeratedly developed in the fossil and in *Staurotypus* and *Graptemys* serves to modify and increase the leverage of the jaw muscles (Zdansky 1924, pp. 101–104). All three genera have widened alveolar surfaces of the maxilla with strong tendency to formation of a secondary palate. In the case of *Graptemys* the wide alveolar surfaces are known to be associated with a malacophagous diet. Probably in the case of the fossil a strengthening of the jaw action and a similar diet are to be inferred.

The dorsal planum of the parietal continues the remarkably flat dorsal margin of the face.

In anterior view the nostril is very small, much as in *Sternotherus*, not as in *Staurotypus*. The prefrontals are anteriorly distinctly convex, posteriorly are very flat. Behind them the frontoparietal area rises somewhat more sharply than in *Staurotypus*.

In palatal view the maxillae have united in the formation of an extensive secondary palate, complete in front with a pronounced median ridge but incomplete in the midline behind. In this secondary palate the palatines share to about the same extent as in *Staurotypus* and to a significantly greater extent than in *Sternotherus*. A striking and unique feature is the very impressive dorsomedial slope of the palatal roof. To a very slight extent this condition is prefigured in the other genera, particularly *Staurotypus*, but the difference is very considerable: in this respect no other genus is at all close. There are no ectopterygoid processes and the pterygoids also are bowed dorsally at the midline, so that their lateral flanges are very strong and high, though spreading wide apart. Anteriorly the premaxilla has the deep pit for the tip of the lower jar characteristic of chelydrids. In the specimen it breaks through into the narial region. As in *Staurotypus* and *Claudius* (differing in this from all examined kinosternines and chelydrines), foramina incisiva appear to be lacking in the fossil. At the postorbital bar the palate, and thus the whole outline of the skull, is very expanded from the side: this form must have been decidedly brachycephalic. The waist of the pterygoids, however, is only moderately broad, as in *Sternotherus*, not very broad as in *Staurotypus* or narrow as in *Claudius*. The basisphenoidal suture is not clearly distinguished from breaks in this region, but it seems probable that the exposed portion of this bone was very short and broad, not tending to be elongate craniocaudally as in *Staurotypus*. The infracondylar depression, so marked in *Staurotypus*, is less distinct in this form, as also in *Sternotherus*, but not so weak as in *Claudius*.

In dorsal view the great breadth of the skull at the postorbital bar is again evident, along with the considerable incurving of the skull contours just in front of the orbits. The origin of the supraoccipital spine is indicated by a triangular plane surface with well defined lateral margins, as in *Staurotypus* and *Sternotherus*, not as in *Claudius*.

The sutures bounding the frontals are somewhat obscured by breaks, but it is extremely probable that as in other Chelydridae the frontals occupy a very small area and do not enter the orbits.

SKULL CHARACTERS IN THE CHELYDRIDAE AND THE ALLOCATION OF THE FOSSIL

For the comparisons made in the course of the description just given I have had available the skeletal collections of the Museum of Comparative Zoology and of the American Museum of Natural History. Included in the M.C.Z. collection are a young and an adult skull of *Staurotypus* (the young specimen, M.C.Z. No. 4989, is figured), while the A.M.N.H. collection has furnished for study a skull of *Claudius* (A.M.N.H. No. 65865).[1]

Because the fossil is a fragment only, comparisons must remain incomplete and portions of the skull which might be diagnostically significant are unavailable. In this circumstance and in the absence of more complete knowledge of variation and difference within the genera *Kinosternon* and *Sternotherus* (valuable information which we may hope to learn in the forthcoming revision of these genera by Dr. Norman Hartweg) I do not attempt to discriminate too finely the affinities of the fossil.

However some rather general discussion is possible. We may first consider what characters define a skull as chelydrid in the broad sense, then what features are chelydrine, staurotypine, or kinosternine, and finally what provisional allocation of the fossil skull is possible and expedient.

There are six genera of living chelydrids (*Chelydra, Macroclemys, Staurotypus, Claudius, Kinosternon, Sternotherus*), and of these *Sternotherus* might quite properly be relegated to the synonymy of *Kinosternon*. The fossil record adds a few more (*Acherontemys, Chelydrops, Chelydropsis, Xenochelys*). In contrast the Testudinidae has about 30 living genera while the fossil record brings the count up to about 50. It is not surprising, therefore, that the Chelydridae seem a more closely knit group than do the Testudinidae, even if the rather isolated *Platysternon* is omitted from the latter assemblage.

If the skulls of chelydrids (all living forms North America, a few Tertiary fossils European) are compared only with the skulls of North American or European testudinids very clear distinctions are evident. If, however, the comparison is extended to the very rich testudinid fauna of Southeast Asia where, so far as known, chelydrids have never occurred, some of the forms to be found there bridge over the differences which were thought to be significant. Even so astute an observer as Baur, and one so familiar with the testudinate order, found it possible

[1] A discussion of the anatomy of *Claudius* is in preparation.

to refer *Adelochelys* (= *Orlitia*) to the "Chelydroidea" when he had the skull only, though the shell would have placed the genus without question in the Emydinae.

The distinctions between the Chelydridae and Testudinidae are wide enough, when all parts of their anatomy are taken into account and the trends within them are considered, that there is no doubt that, although related, they have long been separated, perhaps since the Cretaceous, certainly since earliest Tertiary. Thus there are differences in cervical formula (Williams 1950), in the form of the eighth cervical vertebra, in degree of development of the costiform processes of the nuchal, in the presence versus absence of inframarginals, in the characteristic reduction of the plastron or its elements in the Chelydridae, in the proximal end of the femur, and in the absence in chelydrids of gaudy or bright patterns.

However, in a way which seems very characteristic of turtles, few of these features hold good with complete fidelity in all cases. In cervical formula there is a striking difference between the two families in that the eighth cervical is biconvex in the Testudinidae, procoelous in the Chelydridae. A few individuals of the Testudinidae (mostly advanced tortoises) vary in the direction of the condition of the Chelydridae, but no chelydrids are known to vary in the direction of the testudinid condition. The eighth cervical vertebra tends to differ in the two families, the Testudinidae generally showing three ventral crests on the centrum, though the lateral ones may be barely indicated, the Chelydridae showing a single median crest which may divide into two (some *Chelydra*, kinosternines).

The costiform processes of the nuchal are typically much developed in the Chelydridae, relatively little developed in adult testudinids, but the kinosternine section of the chelydrids approaches the condition of the testudinids, and young emydines have this process rather strongly developed. Inframarginals are never normally present in most testudinids, but there is an exception in the case of *Platysternon*, and inframarginals do occur as individual variations in *Chrysemys picta* (A.M.N.H. specimens to be reported on by Samuel McDowell). The plastron is never reduced in testudinids; it is strikingly reduced in protective efficiency in chelydrines and staurotypines; in some species of the kinosternines it regains its complete coverage of the ventral surface, but prior to this redevelopment it had lost one of the bones normally present in unreduced plastra. In the testudinid femur a fusion of the trochanters tends to limit the intertrochanteric fossa to a shallow dorsal pit, though a number of emydines (and *Platysternon*)

have the juncture barely suggested. In chelydrids as in most turtles the intertrochanteric fossa is a widely open groove. The lack of bright patterns in the Chelydridae, while characteristic enough of the relatively few genera and species involved, is not consistently contrasted with the presence of such patterns in the testudinids (see, for example, the uniform pigmentation of Galapagos tortoises and of some of the Asiatic emydines.)

Nevertheless, in spite of these exceptions, these postcranial characters, external and internal, permit in combination a clear discrimination of the two families.

Several characters distinguish the skulls of chelydrids and testudinids, but here even more than in postcranial characters exceptions reduce the utility of single characters.

Chelydrids usually possess at least traces or indications of a sharp median beak or "tooth" on the upper jaw. But this is absent in some kinosternines, and while many testudinids have a notch here, a few (e.g., *Terrapene, Cuora*) have a beak quite similar to that of chelydrids. Most testudinids (but not *Malaclemys*) have the temporal bar deeply emarginate from below; the chelydrids have this bar at most shallowly emarginate. Chelydrids have the nostril, orbits, and otic opening somewhat smaller than is frequently the case in testudinids. The supraoccipital crest is higher or more steeply arched, the premaxillary pit is usually deeper, and in staurotypines and kinosternines there is a more marked festooning of the contours of the upper jaw than occurs in testudinids. The frontals are always small and excluded from the orbit in chelydrids; this feature is variable in testudinids.

A combination of most of the characters mentioned defines a chelydrid skull. The absence of all but one or two, most often of all, defines a testudinid as contrasted with a chelydrid skull.

Within the Chelydridae determination of chelydrine skulls from staurotypine and kinosternine skulls is at once possible on one key character which offers no difficulty. All chelydrines have the temporal region more fully covered than do any of the more advanced genera.

Discrimination of staurotypine as against kinosternine skulls is more difficult on the basis of any characters which have the smallest probability of holding good if more genera are discovered. Perhaps the premaxillary beak is always more strongly developed in staurotypines and the temporal bar narrower vertically in the same group.

This difficulty in finding differences in the skulls of these two groups is akin to the difficulty in distinguishing dorsal shells. The shells of both subfamilies differ from those of chelydrines in the loss of one pair

of marginal scutes and one pair of peripheral plates. Shape and height of the shells and scute shape are essentially the same. Keeling is variable. Only in the plastron is a key difference at once apparent in the absence of an entoplastron. The mobility of anterior and posterior plastral lobes in kinosternines is another differentiating feature.

In which of these groups does the fragmentary Oligocene skull find its natural place?

It is clearly chelydrid *sensu lato*. It has the sharp premaxillary beak and deep premaxillary pit of a chelydrid. The temporal bar is broken but there is no suggestion of ventral emargination. The nostrils and the orbits are quite small. The supraoccipital crest is only partially preserved but its root gives evidence of a high arch as in typical chelydrids.

The skull is, however, clearly not chelydrine, since the temporal region is fully exposed by posterior emargination as in the two advanced subfamilies, not as in chelydrines. But the postorbital bar is wider than in any staurotypine or kinosternine; this may be a primitive feature.

Is it staurotypine or kinosternine?

It has resemblances to both groups. The premaxillary beak is very strong as in staurotypines, but the temporal bar is very stout in vertical depth as in kinosternines. The pterygoid waist is moderately broad as in kinosternines, not very broad as in *Staurotypus* or very narrow as in *Claudius*. The nostril is very small as in kinosternines and in contrast to the condition in staurotypines. Foramina incisiva are lacking as in staurotypines.

Some features, however, are extremely specialized. The degree of development of the secondary palate is greater than in any presently recognized chelydrid species, significantly greater than in *Staurotypus*. Quite unique (unique in the order) is the extreme obliquity and dorsal arching of the secondary palate.

All in all, the skull seems more specialized than that of any living staurotypine, but at the same time more primitive in at least one respect (the strong premaxillary beak) than any living kinosternine, and perhaps more primitive in the width of the postorbital bar than either modern staurotypines or modern kinosternines.

The skull is Oligocene in age. The only known shell to which it might belong is *Xenochelys*, of the same age and not distant in locality. But the shell of *Xenochelys* is quite primitive for its group. Can so specialized a skull be assigned with any probability of correctness to so primitive a shell?

Such an association is by no means impossible. Indeed, in the Princeton skull a few features like the very strong premaxillary beak and the wide postorbital bar may point to a stage of differentiation not very different from that of the *Xenochelys* shell: advanced in some respects, primitive in others. For the present it seems expedient to refer the Princeton skull — with doubt — to *Xenochelys formosa* Hay.

THE GEOLOGIC RANGE OF THE CHELYDRIDAE

The Princeton skull and the American Museum shell of *Xenochelys formosa* are the oldest known representatives of the Chelydridae (Chadronian Oligocene). An older fossil from the Eocene of Tunis was indeed referred to the family by De Stefano (1903), but his description was based on a few bone fragments associated with the mold of three pleurals. The generic and species names, *Gafsachelys phosphatica*, erected on this very insufficient basis may be disregarded as a *nomen vanum* and need no longer be considered as part of the fossil history of the Chelydridae.

It is, of course, surprising that the oldest representatives of the family should be staurotypine rather than chelydrine. It is, however, possible that future more complete knowledge may connect some of the other forms called dermatemydine by Hay (1908) with the Chelydridae. The type species of *Hoplochelys* Hay was first called *Chelydra crassa* by Cope, and this genus, though possessed of a full complement of marginals and peripherals was regarded as possibly related to *Staurotypus* by Hay himself. Both this genus (Paleocene of North America) and *Baptemys* (Lower and Middle Eocene of North America) have the plastron considerably reduced, the bridge narrowed and the posterior lobe pointed, and an arrangement of plastral scutes like that of Recent *Chelydra* (pectorals meeting femorals). The shape of the shell in both genera is quite like that of staurotypines and kinosternines, and in *Hoplochelys* the shell is tricarinate, as it is also in one species of *Baptemys*. The humerus of *Baptemys tricarinata* is very like that of *Chelydra*. However, the first vertebral is never elongate as in staurotypines and kinosternines. The other vertebrals are never as wide as in chelydrines, though wider in later (Torrejon) than in earlier (Puerco) *Hoplochelys*. The costiform process of the nuchal is said to be short in *Baptemys* (Hay, 1908). The skull of *Baptemys wyomingensis* is known and is quite un-chelydrid in its major characters: the temporal bar is deeply emarginate from below, and the temporal region widely open above, there being a much greater caudal emargination than in

chelydrines. The postorbital bar is in consequence relatively narrow. The orbit also is rather large.

None of the conditions just mentioned in which *Baptemys* and *Hoplochelys* differ from chelydrids positively debars them from ancestry. For the present, however, and until they are better known and transitional forms are discovered, it seems convenient to retain them in the Dermatemydidae, merely calling attention to their possible special relation to the Chelydridae.

Unless these forms, perfectly suitable in age, are ancestral chelydrids, there is no record of the family until the early Oligocene, and it is then first represented, as the shell and the referred skull of *Xenochelys formosa* show, by an advanced subfamily.

The first occurrence of apparent Chelydrinae is in Europe and later in the Oligocene. Fragments of doubtful value from the middle Oligocene of Germany have been assigned to "*Chelydra* sp." by Reinach (1900), and in the later Oligocene of Germany rather good remains are found of an undoubted chelydrine, "*Chelydra*" *decheni* v. Meyer. Reference of the latter form to the Recent genus *Chelydra* is, as Zangerl (1945) has already pointed out, extremely doubtful: though the shell shape is that of a chelydrine, there are curious resemblances to *Staurotypus* and to *Macroclemys* rather than to *Chelydra*. Indeed, H. v. Meyer himself in 1852 expressly admitted that the inclusion of this form in *Chelydra* depended upon a very wide generic concept, and his idea of the genus was very definitely much wider than that current today.

In the Miocene of both Europe and North America there is a flowering out — real or apparent — of chelydrine types. In Europe "*Chelydra*" *murchisoni* Bell and four other named species of "*Chelydra*" and *Chelydropsis carinata* Peters record the rather widespread occurrence of the subfamily. The remarks above for "*C.*" *decheni* apply also to "*C.*" *murchisoni* and the other European forms referred to "*Chelydra.*"

The carapace of *Chelydropsis carinata* has been excellently figured by Peters (1869). Unfortunately it does not seem possible to verify in his figure the features upon which Peters relied in distinguishing this form generically. I am unable to interpret the plate as showing the presence of supramarginals, and while a division of the nuchal bone into two parts is clearly shown, I (as also Boulenger in 1889) doubt that this reflects the normal condition of the animal. Nevertheless, I consider it probable, if only on the grounds of zoogeography and age, that the genus will stand, though requiring redefinition. It

may at least be pointed out that if the eventual much needed restudy of the European chelydrines should reveal that they all belong to one genus, the name *Chelydropsis* is available.

From the Miocene of North America three chelydrines have been described. Two are known from skulls only: *Chelydrops stricta* Matthew and *Macroclemys schmidti* Zangerl. Both of these are from Nebraska, *M. schmidti* from the Middle Miocene, *Chelydrops stricta* from the Upper Miocene. Both are certainly related to Recent *M. temminckii*, but they are distinct from that form and from one another. *Chelydrops* is unique among known chelydrids in having a ridged alveolar surface of the maxilla.[1] *M. schmidti* differs from *Chelydrops* and from *M. temminckii* by the considerably shorter antorbital portion of the face.

The other Miocene North American form (from the Roslyn Miocene of Washington) is known from the carapace only, no portion of the plastron nor any skeletal parts having been recovered. Hay described this form as a new genus and species, *Acherontemys heckmani*, because of the close articulation of pleurals and peripherals and because the vertebrals were even broader than in living chelydrines. This shell may belong to either or neither of the forms represented by the skulls before mentioned.

Zangerl (1945) has described a skull fragment from the Pliocene (Clarendonian) of South Dakota, which is indistinguishable from Recent *M. temminckii*. Gilmore (1923) has described from the San Pedro Valley of Arizona, either Pliocene or Pleistocene, a *Kinosternon* which is said to differ from Recent *K. flavescens* mostly in size.

Two species of *Chelydra* and one of *Macroclemys* have been described by Hay from the Pleistocene of Florida. The value of these forms, based on fragmentary material, will be difficult to determine. There are also scattered Pleistocene records for the Recent species *Chelydra serpentina* and *Macroclemys temminckii*.

Acknowledgments. I am indebted to Dr. Glenn L. Jepsen for the privilege of studying and describing the Princeton skull. Mr. Arthur Loveridge and Mr. C. M. Bogert have generously made available the comparative Recent material under their care in the Museum of Comparative Zoology and the American Museum of Natural History respectively. Dr. E. H. Colbert permitted examination of the types of *Xenochelys formosa* and *Chelydrops stricta*. Dr. A. S. Romer and Mr. L. I. Price have read the manuscript. Mr. Sam McDowell is to be credited with the drawings and a number of useful suggestions.

[1] The type and figured adult skull fragment has this ridge. The young specimen referred by Matthew to this form lacks the ridge.

TABLE 1. FOSSIL SPECIES OF THE CHELYDRIDAE

OLIGOCENE:

Xenochelys formosa Hay
Chadronian Oligocene (S. Dakota) North America
"Chelydra" decheni v. Meyer
Upper Oligocene (Siebengebirge) Europe

MIOCENE:

"Chelydra" murchisoni Bell
Miocene (Oeningen) Europe
Chelydropsis carinata Peters
Miocene (Eibiswald) Europe
"Chelydra" meilheuratiae Pomel
Miocene (Allier) Europe
"Chelydra" lorettana (v. Meyer) Glaessner
Miocene (Leithagebirge) Europe
"Chelydra" argillarum Laube
Miocene (Preschen) Europe
"Chelydra" allinghensis E. Fuchs
Miocene (Viehhausen) Europe
Macroclemys schmidti Zangerl
Middle Miocene (Nebraska) North America
Chelydrops stricta Matthew
Upper Miocene (Nebraska) North America
Acherontemys heckmani Hay
Miocene (Washington) North America
and additional European records for *"Chelydra* sp." and *"Macroclemys* sp."

PLIOCENE:

Macroclemys temminckii (Holbrook) Zangerl
Early Pliocene (S. Dakota) North America

PLEISTOCENE:

Macroclemys floridana Hay
Pleistocene (Florida) North America
Chelydra laticarinata Hay
Pleistocene (Florida) North America
Chelydra sculpta Hay
Pleistocene (Florida) North America
Kinosternon arizonense Gilmore
Pleistocene (Arizona) North America
and additional North American records for *M. temminckii* and *C. serpentina*

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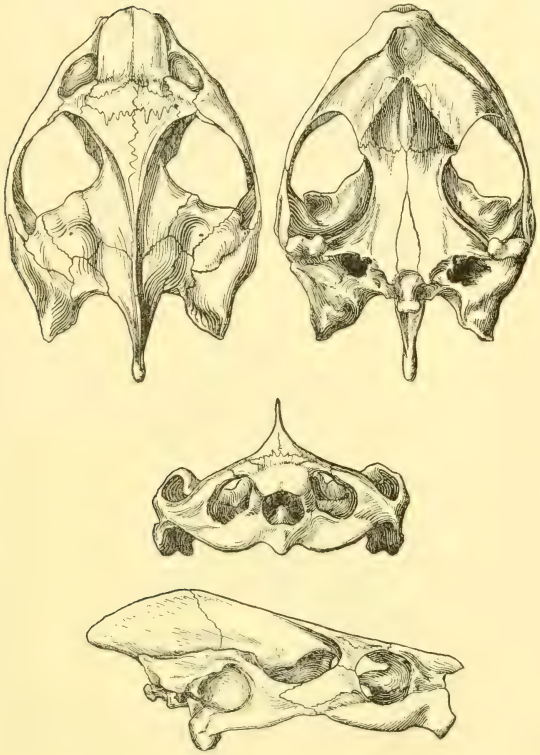


PLATE 1

Staurotypus salvinii M.C.Z. 4989: Dorsal, ventral, anterior and lateral views of skull. X about 1¼.

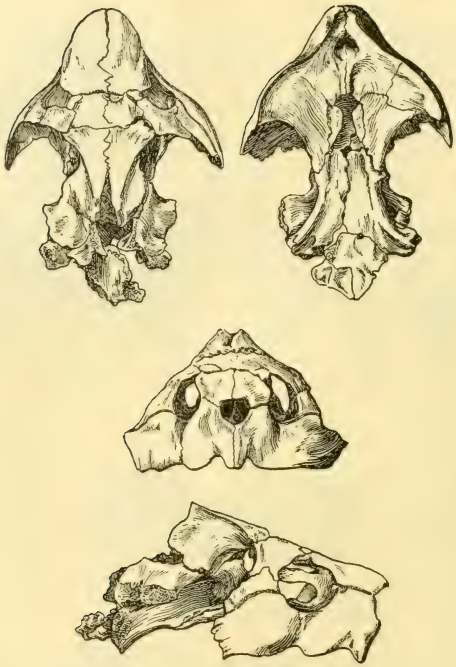


PLATE 2

Xenochelys formosa Princeton 13686: Dorsal, ventral, anterior and lateral views of referred skull fragment. About natural size.

BREVIORA

Museum of Comparative Zoology

CAMBRIDGE, MASS. MAY 23, 1952 NUMBER 3

NOTES ON SIPHONOPHORES

3. *Nectopyramis spinosa* n. sp.

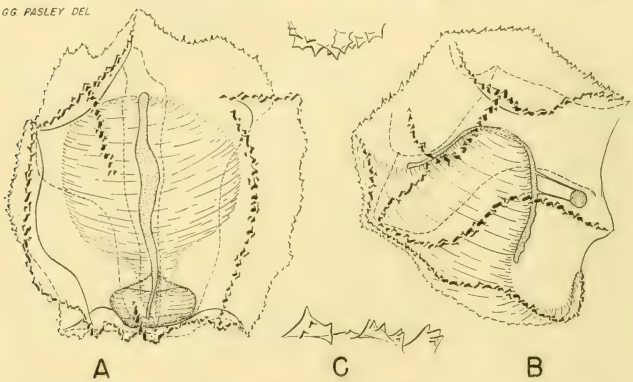
BY MARY SEARS[1]

In a number of samples collected by the "Dana" in tows with 1000 to 3000 meters of wire out, there were several nectophores and bracts with rows of peculiar jagged spines (Fig. C). These spines are quite unlike those on other deep-dwelling species, such as *Vogtia pentacantha* Kölliker, *V. spinosa* Keferstein and Ehlers, and *Athorybia rosacea* Forskål. In fact, the specimens have little in common with either the Hippopodidae or the Anthophysidae. However, one nectophore was described by Moser (1925, p. 425, Pl. 25, figs. 5–7) as *Hippopodius* (?) *cuspitata*, although it actually closely resembled the specimens found in the "Dana" collection. The chief difference is that hers had the peculiar jagged spines scattered irregularly over its surface, whereas on the "Dana" specimens these are arranged in discrete rows. Nevertheless, the spines themselves seem to be identical in structure. Like the "Dana" nectophores, most of the characteristics described and figured by Moser (1925) make it appear almost certain that her specimen was also a *Nectopyramis*, not a *Hippopodius*. In all examples, the shape of the nectosac, its relation to the hydroecium, and the fact that the nectophores have all been taken singly and at considerable depths are all peculiarities of *Nectopyramis*. On the other hand, the somatocyst is tubular and not "represented by a series of divergent canals" (Bigelow, 1911a, p. 338) as defined in the brief description of the genus.

The original account was based on one species, *Nectopyramis thetis*. Soon thereafter a second species, *Nectopyramis diomedeae*, with many of the same characteristics was recorded (Bigelow, 1911b). Since then no additional species have been reported, and little more has been

[1] Papers from the "Dana" Collection No. 38, and Contribution No. 607 of the Woods Hole Oceanographic Institution.

learned about the genus. Hence, there has been little reason for modifying the original description. Nevertheless, our ideas concerning the relationships of this genus have changed considerably. Thus, the family of the Monophyidae has been broken up and the individual genera transferred to other well-established families (Totton, 1932, p. 328) with which they had obvious affinities. *Nectopyramis*, therefore, is now referred to the Prayidae. In this family, the somatocyst and radial canals are structurally quite varied; in some, they are simple, in others branched. At first, these were used as a criterion for separating genera (Bigelow, 1911b), but more recently, a transitional form with branched radial canals and a simple somatocyst has been



discovered (Leloup, 1934, p. 11). This suggests that when more is known about this family, differences in the structure of somatocyst and canals may prove to be of specific rather than generic value.

If, then, we consider that the shape of the somatocyst is in all probability a specific character in *Nectopyramis*, as may be the case among other prayids, we have two species originally described by Bigelow (1911a; 1911b), *N. thetis* and *N. diomedeae*, both of which had branched somatocysts, but simple radial canals and two species, *N. cuspitata* Moser and *N. spinosa* n. sp. (described below) with simple tubular somatocysts. The two latter are both spiny, but the two are readily distinguished for Moser's species is irregularly covered by the spines, but in *spinosa* these are arranged in regular rows along more or less distinct ridges.

Nectopyramis spinosa n. sp.

The type specimen is a nectophore about 5 mm. in length taken at "Dana" St. 3933[IV] at 11°18′S., 50°13′E. on 20 December, 1929, in a stramin net 150 cm. in diameter towing with 2000 meters of wire out. The type specimen will be deposited in the University Museum, Copenhagen, Denmark.

Other specimens were taken as follows:

St. 3556[II]. 2°52′N., 87°38′W. 14. IX. 1928.
S150. 2000 m. wire. 1 nectophore.
St. 3677[IV]. 5°28′S., 130°39′E. 23. III. 1929.
S150. 2000 m. wire. 2 bracts.
St. 3920[VI]. 1°12′N., 62°19′E. 9. XII. 1929.
S150. 1000 m. wire. 1 bract.
St. 3964[VI]. 25°19′S., 36°13′E. 15. I. 1930.
E300. 3000 m. wire. 1 bract.
St. 3998[III]. 7°34′S., 8°48′W. 1. III. 1930.
S150. 1000 m. wire. 1 bract.

Nectophore (Fig. A). The unique rows of jagged spines make it obvious that the nectophore is new. Although probably flattened on preservation, in dorsal or ventral view, it is roughly triangular much as are the nectophores of the other known species of *Nectopyramis*. The nectosac opens into the base of the triangle and like *N. thetis* "is comparatively small, shallow, and saucer-shaped" (Bigelow, 1911a, p. 338) with four primary radial canals along its sides. It is uncertain whether or not these eventually branch because of preservation. A large deep hydroecium lies just above it with a slit-like opening on the ventral surface. This extends the entire length of the hydroecium. The somatocyst insofar as can be determined appears to be a tubular rod extending from the base of the hydroecium to slightly above its apex. The stem and appendages are entirely missing.

Bract (Fig. B). Although bracts have not been found attached to the nectophore, there seems to be little doubt that the bracts with rows of the same jagged spines belong to this species. These are globular, about 2.5 mm. high and slightly more than 3 mm. wide. As in the nectophore, the hydroecium is so deep that it extends somewhat into the upper half of the bract. Closely associated with the hydroecium is a long tubular somatocyst which follows the outline of the hydroecium. On two of the specimens, two threadlike branches are given off dorsally and appear distally to have a globular connection.

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BREVIORA

Museum of Comparative Zoology

CAMBRIDGE, MASS. JUNE 9, 1952 NUMBER 4

A UNIQUE REMOPLEURIDID TRILOBITE

By H. B. WHITTINGTON

INTRODUCTION

The species described below, and made the type of a new genus, has been known for more than 75 years. Previous illustrations are both few and inadequate, and no attempt had been made to reconstruct the exoskeleton. When such an attempt is made (text-fig. 1) this unique remopleuridid is shown to have been a most unusual trilobite, in which the long, forked hypostome reached back to the anterior margin of the pygidium. It could not enroll, as it would seem that many (or most) trilobites could. If the hypostome was rigidly attached to the cephalic doublure, then only very restricted movements of the thorax and pygidium, relative to the cephalon, were possible.

I am indebted to Dr. G. Arthur Cooper, U. S. National Museum, Washington, D. C., for allowing me to study and photograph material in his charge.

SYSTEMATIC DESCRIPTION

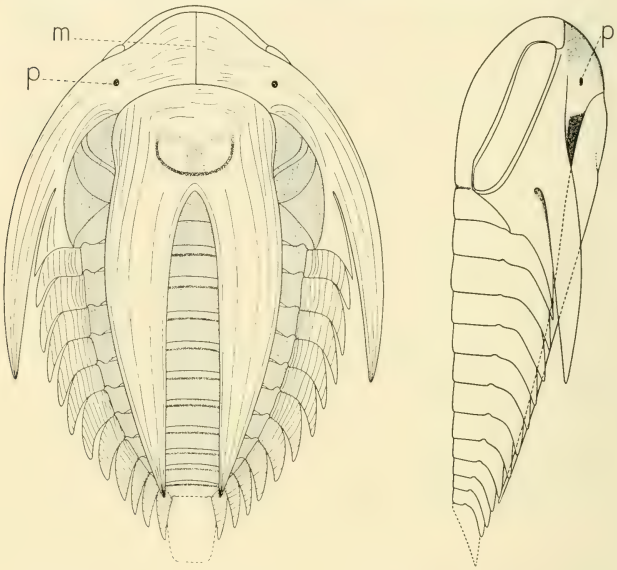
Family REMOPLEURIDIDAE Hawle and Corda, 1847

Genus HYPODICRANOTUS gen. nov.

Type species. *Remopleurides striatulus* Walcott, 1875, pp. 347–349, fig. 27, from C. D. Walcott's locality in the Trenton limestone of Trenton Falls, Oneida Co., New York.

Discussion. The cephalon of *Hypodicranotus striatulus* differs from that of the type species of *Remopleurides* (Whittington, 1950, pp. 540–

543, Pl. 70, figs. 1, 2, 4, 5) in that: (a) the anterior part of the glabella, the tongue, projects for a greater distance in front of the eyes; (b) three pairs of glabellar furrows are present, and the second is relatively farther back than that of *Remopleurides*; (c) the broad spine that curves back beside the thorax is not the genal spine, but a lateral cephalic spine; (d) the hypostome is long and deeply forked, not a



Text-figure 1. *Hypodicranotus striatulus* (Walcott, 1875). Reconstructions of ventral (left) and right lateral (right) appearance of outline of exoskeleton, approx. X 3, based upon M. C. Z. Nos. 1616, 1617. The positions of the raised lines on the cephalic and thoracic doublure and the hypostome are indicated in the ventral view. *m* = median suture; *p* = pit in doublure. In both drawings a general outline of the pygidium is indicated by dotted lines.

sub-rectangular plate wider than long. The thorax of *Hypodicranotus* probably consists of eleven segments, and is like that of *Remopleurides*, with the wide axis, prominent articulating processes and sockets, diagonal pleural furrows, and backwardly curved and pointed pleurae.

The axial and pleural furrows in *Hypodicranotus* are shallow, there are no axial spines, and no segment has the pleural spines exceptionally elongated. The pygidium of *Hypodicranotus* is poorly known, but appears to be rectangular in outline, longer than wide, with the axis much shorter than that of *Remopleurides*. The dorsal exoskeletons of other remopleuridid genera may readily be distinguished from that of *Hypodicranotus* or *Remopleurides*.

Hypodicranotus is known from the Trenton Group of New York and Ontario, from rocks of the same age in Wisconsin, the Prosser limestone of Minnesota, the Kimmswick limestone of Missouri and Illinois, the Viola limestone of Oklahoma, and from the Ordovician strata at Silliman's Fossil Mount, Baffin Island.

Hypodicranotus striatulus (Walcott, 1875)

Plate 1, figs. 1–10; text-figure 1.

Lectotype (selected Raymond, 1925, explanation of Plate 3). Mus. Comp. Zool. No. 1616, original of Walcott, 1875, p. 347, fig. 27A, from the dark-gray colored Trenton limestone of Trenton Falls, Oneida County, New York. The large collection from this locality in the Museum of Comparative Zoology includes the trilobites *Ceraurus pleurexanthemus* Green, 1832; *Calliops callicephalus* (Hall, 1847); *Leonaspis ? trentonensis* (Hall, 1847); *Diacanthaspis ? parvula* (Walcott, 1879); *Illaenus* cf. *americanus* Billings, 1859; *Isotelus gigas* DeKay, 1824; *Flexicalymene senaria* (Conrad, 1841), as well as bryozoans, brachiopods, crinoids and asteroids. This locality, from which both W. P. Rust and Walcott collected, is probably in the Denmark member of the Sherman Fall formation of Kay (1937, pp. 267–268).

Paratypes. Mus. Comp. Zool. Nos. 1617, 1618, 1537, same locality and horizon. Additional material, cranidia and hypostomes, is included under Mus. Comp. Zool. Nos. 3267–3269. No. 1617 is original of Walcott, 1875, p. 347, fig. 27a.

Description. Dimensions of lectotype, Mus. Comp. Zool. No. 1616, in millimetres:

Cephalon:

Length (sagittal)	10.4
" (exsagittal)	18.2
Width at genal angle	16.4
Height at second glabellar furrow	6.5
Maximum width across palpebral lobes	11.2
Length of eye lobe	7.2

Thorax:

Width axis first segment 10.2
" " ninth " ,approx. 4.3
" first segment (across tips of pleurae) 13.6
" seventh segment (across tips of pleurae) 7.7
Length (sagittal) complete thorax, approx. 13.0

Dimensions of hypostome, Mus. Comp. Zool. No. 1617, in millimetres:

Length (sagittal) 5.2
" (exsagittal) 20.2
Maximum width (at about half the length) 7.4
Width of middle body 3.7

The cranidium includes the occipital ring, glabella and tongue, and palpebral lobes. The occipital ring is longitudinally flat, transversely moderately convex, bounded laterally by the posterior branches of the facial sutures, which are straight but run diagonally back from the posterior corner of the eye lobe, then curve to run into the posterior margin at right angles. Inside and parallel to the suture is a faint depression, the axial furrow, and just inside the point where the suture cuts the posterior margin is a rounded notch, the articulating socket. The occipital furrow is shallow. Between the eye lobes the glabella and palpebral lobes are gently and evenly convex both longitudinally and transversely. In the mid-line the tongue of the glabella of the lectotype projects forwards 1.8 mm. in front of the eye lobe, and is convex and bent down so that the anterior part overhangs the sutural margin. There are three pairs of glabellar furrows, visible because they are both unornamented and slightly depressed (Pl. 1, figs. 2, 4). Each furrow runs in a curve convex forwards, and they are equally spaced from each other, the distance (exs.) between them slightly less than the equal distance (exs.) of the outer end of the first from a point opposite the posterior end of the eye lobe, and the outer end of the third from a point opposite the anterior end of the eye lobe. The furrows commence a short distance inside the palpebral furrow, and do not extend to the mid-line. The first is the most strongly convex, the second commences farthest out, and the third farthest in. The palpebral rim is flat, depressed slightly below the lobe, outwardly sloping, widest posteriorly, narrowing forwards and disappearing at the anterior end of the eye lobe. Posteriorly the palpebral furrow runs into the junction of the extremity of the occipital furrow and the axial furrow. The eye lobe is long, in dorsal aspect curved, most strongly in the posterior part. The eye surface is gently convex

transversely, and slopes steeply. The arrangement of the minute, convex facets is shown in Plate 1, figure 10. The outer margin of the eye lobe is defined by a narrow, convex border which commences at the posterior corner and runs forwards to merge anteriorly with the border of the cheek. The anterior branches of the facial suture curve to run at first forwards and inwards from the outer, anterior, corner of the eye lobe, and then run inwards and upwards to the mid-line. Thus in anterior aspect (Pl. 1, fig. 5) the margin of the tongue is a curve convex upwards. The free cheek is triangular in outline, outwardly sloping, widest behind the eye lobe, the genal spine short and pointed. The cheek narrows forwards to disappear opposite the anterior part of the eye lobe. From the lateral border opposite the median part of the eye lobe a broad spine curves back, narrowing and reaching to a point opposite the axis of the fifth thoracic segment. The inner margin of the proximal part of this spine is parallel to, and just outside of, the outer margin of the cheek and genal spine. The doublure of the cephalon is broad anteriorly, gently convex, crossed by a median suture. Antero-laterally and laterally the doublure is narrower and bent upwards. A small pit is situated on the exsagittal line passing through the anterior end of the eye lobe, and about mid-way across the doublure (Pl. 1, fig. 8; text-fig. 1). The hypostome is long and forked, and its position relative to the rest of the exoskeleton is shown in text-figure 1. It is gently convex, in both longitudinal and transverse directions, the transverse convexity greatest at the curved anterior margin. The convexity (in ventral view) is interrupted only by the shallow depression in the median region just in front of the crotch of the fork. The middle body is circular in outline, faintly elevated, defined postero-laterally by a distinct furrow. It is divided into three sub-equal sections by shallow radial depressions, the strongest leading back to the crotch of the fork, the other two directed antero-laterally (Pl. 1, fig. 7). On the inside of the exoskeleton of a smaller specimen (Pl. 1, fig. 9) these sections appear more pronounced, and on both sides the postero-lateral pair are the more prominent. Anteriorly the middle body merges with the border, and the anterior wings appear to be short, triangular, and upwardly directed. Each postero-lateral border is extended as a prong of the fork, the inner margin of the prong straight, the outer margin curved, so that the maximum width of the hypostome is in front of half the length, and the prong tapers to a sharp point. The doublure of the hypostome (Pl. 1, figs. 4, 9) is narrow along the lateral border, but extends in under the fork to a line almost under the margin of the middle body.

The inner edge of the doublure is flexed up sharply. Mus. Comp. Zool. No. 1618 (Pl. 1, fig. 4) shows that the doublure of the prong is convex dorsally, with a low, median, longitudinal ridge.

The thorax is moderately convex transversely, the axis broad, narrowing rapidly backwards. It seems to consist of eleven segments. On the left side of the lectotype 10 segments can clearly be seen (Pl. 1, fig. 2). Behind this only what may be part of the left pleura of the eleventh segment, and part of the pygidium, are preserved. Another specimen (Pl. 1, fig. 6) shows ten partly disarticulated segments and an incomplete pygidium The last segment has the pleura pointing almost directly posteriorly, whereas that next in front has the pleura directed back and slightly outwards, and the lateral margins are curved. This penultimate segment is very like the tenth of the lectotype. The axial ring is moderately convex transversely, the articulating furrow shallow, the articulating half-ring of length (sag. = sagittal) about half that of the ring (Pl. 1, fig. 6). There is no axial furrow as such, but inside the articulating sockets and processes a triangular area (broadest anteriorly) of the outermost part of each ring is slightly depressed. The inner margin of this area is a diagonal curved line sub-parallel to the pleural furrow. The articulating process, on the anterior margin of the segment, is slightly raised as well as forwardly projecting. Postero-laterally the inflation is continued across the pleura as a low, curved ridge, dying out at about two-thirds (exs. = exsagittal) the length. This ridge, and a depression on the inner side, define the pleural furrow. The pleurae are gently convex (tr. and exs.), outwardly sloping, the narrow (tr. = transverse) inner part directed transversely, the outer part curved back and pointed. The shape and inclination of the pleurae are shown in Plate 1, figures 1, 2, 6.

Only a small part of the pleural lobes of the pygidium is preserved in the lectotype. The only other specimen known (Pl. 1, fig. 6) is also incomplete. The outline was evidently rectangular, longer than wide, the ill-defined axis convex, short, and wide. Behind and beside the axis the pleural lobes slope down in a curve concave in longitudinal profile. The lateral and posterior margins, and the doublure, are unknown.

Scattered over the cranidium, but largest and most closely spaced on, and adjacent to, the palpebral lobes (though absent from the palpebral rim), are small crescentic depressions, the points of the crescent facing forwards, and the concave, anterior margin raised (Pl. 1, figs. 1, 2, 4). Similar but larger structures are present on the

free cheeks, the genal spine, and the base and outer part of the long lateral spine (Pl. 1, fig. 1). There is a tiny median tubercle on the occipital ring, closer to the furrow than the posterior margin. Faint, small crescentic depressions are scattered on the median part of the axis of the thorax. Strong, well-spaced, raised lines run approximately longitudinally on the inner part of the lateral cephalic spine, the thoracic pleurae, and on the doublure of these areas and the cheeks (Pl. 1, figs. 1–4, 6, 8). The lines tend to run in curves convex inwards on the dorsal surface of the pleurae, and transversely in curves convex forwards on the dorsal surface of the pygidium. On the inner part of the doublure of the thoracic pleurae, however, they run in curves concave inwards. These lines die out on the median part of the cephalic doublure, and are replaced by faint, anastomosing, transverse grooves. On the lateral borders and fork of the hypostome (Pl. 1, fig. 7) the longitudinal lines are strongest, and that which runs just inside the inner margin of the prongs is a prominent ridge. The middle body shows a faint pattern of narrow, anastomosing ridges running longitudinally on the postero-lateral sectors. On the anterior sector of the middle body and the anterior border, fine, well-spaced, anastomosing grooves, like those on the median part of the cephalic doublure, run transversely.

Discussion. This species was first described by Walcott (1875, pp. 347–349, fig. 27), and the original material later redescribed by Raymond (1925, pp. 57–58, Pl. 3, figs. 4, 5). An incomplete cranidium from the same general locality as the type (U. S. Nat. Mus. 92528) was also figured by Foerste (1920, p. 222, Pl. 22, figs. 18 A–C). Raymond (1921, p. 31, Pl. 9, fig. 7) described a hypostome from the Middle Trenton of Trenton, Ontario, and referred it to *H. striatulus*, and stated that a cranidium had also been found at Governor Bay, near Ottawa. Specimens kindly loaned to me by Professor G. Winston Sinclair, from the Middle Trenton of Lakefield, Ontario, contain cranidia and hypostomes like those of the type material. A second species of *Hypodicranotus* is *H. missouriensis* (Foerste, 1920, pp. 220–222, Pl. 21, fig. 17; Pl. 22, figs. 17A, 17B; Bradley, 1930, pp. 246–247, Pl. 30, figs. 4–9) from the Kimmswick limestone of Missouri and Illinois. The type material (U. S. Nat. Mus. No. 78438) includes cranidia and a hypostome. The outline of the latter, and the prominence of the postero-lateral areas of the middle body, distinguish it from *H. striatulus*. The characteristic hypostome of *Hypodicranotus* also occurs in the Trenton of Duck Creek Quarry, near Green Bay, Wisconsin (U. S. Nat. Mus. Nos. 72181, 87687), the Prosser limestone

of St. Paul, Minnesota (U. S. Nat. Mus.), and I have collected one from about 100 ft. above the base of the Viola limestone, in the road cut on U. S. highway 77, in Carter County, 2½ miles north of Springer, Oklahoma. The matrix at this locality was a finely-granular, light grey-brown limestone, which yielded abundant graptolites and the trilobites *Cryptolithoides ulrichi* Whittington, 1941, *Trinodus* sp., *Robergia* sp., and an asaphid. The specimen figured by Roy (1941, p. 155, fig. 114), as *Remopleurides* sp., from Silliman's Fossil Mount, Baffin Island, seems also to be the hypostome of this genus The genus thus occurs in central and eastern North America in rocks of Trenton age, and the Baffin Island beds may be of a similar age.

The exoskeleton of *Hypodicranotus striatulus*, apart from the hypostome, is like that of other remopleuridids of Middle Ordovician age, e.g. the Irish specimens (Whittington, 1950, pp. 540–543, Pl. 69, figs. 5–10, Pl. 70, figs. 1–6) and undescribed species from the Edinburg limestone of Virginia. The latter have a sub-rectangular hypostome, not forked, like that of the type species (Whittington, 1950, Pl. 70, fig. 2). The posterior margin reaches back to a point lying no farther back than the occipital furrow. The long, forked hypostome of *Hypodicranotus* is not only unique, so far as is known, among remopleuridids, but its relatively great length is in excess of that of any other trilobite known to me. It is evident that here is one genus of trilobites that could not enroll.

The pit in the antero-lateral cephalic doublure (Pl. 1, fig. 8, text-fig. 1) is a feature which I have observed in several different species of Middle Ordovician remopleuridids. Silicified specimens show the pit to be the opening of an upwardly-directed tube, which narrows inwards and terminates near the lower, anterior corner of the eye surface. The position and nature of this opening do not suggest that it is homologous with the Panderian opening, which, if present in the cephalon, is situated in the postero-lateral cephalic doublure. Not all remopleuridids appear to show this opening (e. g. those described by Ross, 1951, pp. 84–91, Pl. 20, do not), and I have not observed a similar opening in any other group of trilobites.

It is tempting to speculate on the mode of life of the holaspid *Hypodicranotus*. It occurs in company with shallow-water marine forms, many of which are indisputably benthonic. The long hypostome prevented enrollment, but did provide some protection for the ventral surface. If no movement was possible at the hypostomal suture, then the amount of possible movement of the thorax and pygidium in the vertical plane, relative to the cephalon, must have been severely

limited. The mode of articulation of the thorax precludes any considerable movement relative to the cephalon in the horizontal plane. There is ample room for the appendages to project downwards and outwards between the hypostome and the thoracic pleurae. But we know nothing of the type of appendage possessed by remopleuridid trilobites, and without this information have little basis for speculation on the mode of locomotion, manner of feeding, etc. Was *Hypodicranotus* a burrowing, crawling, floating, or swimming form? No definite answer is possible but I am inclined to think of it as either floating or swimming.

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EXPLANATION OF PLATE I

Hypodicranotus striatulus (Walcott, 1875). Trenton limestone, probably Denmark member of the Sherman Fall formation, Trenton Falls, Oneida County, New York, all X 3, except figure 10, X 17½, Mus. Comp. Zool. collections.

Figs. 1–3, 5, 8. Lectotype, No. 1616, left lateral, dorsal, right lateral, anterior, and antero-ventral views, presumed original of Walcott, 1875, p. 347, fig. 27A, and original of Raymond, 1925, Pl. 3, fig. 4.

Figs. 4, 10. Paratype, No. 1618. **4**, dorsal view. The right half of the dorsal exoskeleton of the cephalon and three thoracic segments are preserved; on the left is seen the lateral cephalic spine, and external moulds of the doublure of several pleurae. The left, and tip of the right, prongs of the fork of the hypostome are exposed from the inner side. The hypostome has been slightly displaced. **10**, the anterior portion of the right eye surface, showing the arrangement of the facets.

Fig. 6. Paratype, No. 1537, dorsal view.

Fig. 7. Paratype, No. 1617, ventral view, presumed original of Walcott, 1875, p. 347, fig. 27a, and Raymond, 1925, Pl. 3, fig. 5.

Fig. 9. No. 3269, dorsal view of interior of hypostome.

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BREVIORA

Museum of Comparative Zoology

CAMBRIDGE, MASS. AUGUST 29, 1952 NUMBER 5

TRICHOLIMNAS CONDITICIUS IS PROBABLY A SYNONYM OF *TRICHOLIMNAS SYLVESTRIS*

(Aves, Rallidae)

BY JAMES C. GREENWAY, JR.

Comparison of the type of *Tricholimnas conditicius* Peters and Griscom (Proc. New England Zool. Club, vol. 10, 1928, pp. 99–103) with a series of *Tricholimnas sylvestris* (Sclater) makes it appear most probable that the type specimen is an immature female of *sylvestris*. Furthermore, some recently discovered notes in the handwriting of collector Andrew Garrett cast grave doubt upon the theory that Garrett shot the bird on Apaiang Atoll, between Makin and Tarawa, in the Gilbert Islands, as Thomas Barbour postulated in the original description of the supposed species. Both Mr. Peters and Mr. Griscom agree to this.

Naturalists have wondered since then whether a habitat, such as this low sandy island affords, could have supported a population of these rails. The very distance from congeners on New Caledonia and Lord Howe Island, off the coast of Australia, made this seem unlikely, quite apart from the disparity of habitats. However, the arguments brought forward in the original description were difficult to circumvent.

This type and only known specimen of *conditicius* was found preserved in alcohol in the Museum of Comparative Zoology after a period of long oblivion. With it was a label: "Kingsmill Islands, 1861, Andrew Garrett, Collector". Since it could be proved without question that Garrett was actually on Apaiang Atoll of the Kingsmill, or what is now called the Gilbert group, in the autumn of 1859, it seemed likely that he did collect the bird there and that the date "1861" represented the year of acquisition by the museum. However, it now seems quite

as probable that the specimen has been confused with a consignment of specimens that came from the Kingsmills and that the label was written in the museum under a misapprehension.

Andrew Garrett was a dealer who had in his stock specimens from all over the world. In a letter to Charles E. Hamlin at the Museum of Comparative Zoology, written on April 10, 1878, from Huahine, Society Ids., he says: "In return I shall be glad to receive any land or fresh water shells from the East Indies and marine shells from any part of the world except Eastern States, California, and Polynesia." And again, "You can send me in return for this box *everything* you can spare from your duplicates no matter from what part of the world . . . don't forget the museum publications for which I will send the ferns in compensation."

From Hilo, Hawaii, he writes on Oct. 10, 1856, that he plans a voyage on the whaler 'Lydia', the captain of which was an acquaintance of his.

In a letter to Jas. M. Barnard dated April 29, 1857, and written at Hilo, he gives a short history of his life. He had been a sailor and had visited in past years the "Ladrone, Bonin, Loochoo, some of the Australian and several of the East India Islands . . . my taste for Natural History, which I dearly love, was acquired while visiting foreign places."

The most important bit of evidence has recently been found. A short note in Andrew Garrett's handwriting and on the same paper used by him in his correspondence is entitled "Remarks upon the Birds of Apaiang one of the Kingsmills Is." and is reproduced here in its entirety. It bears no date but was probably written in 1859.

"During my short residence at the above location [Apaiang Atoll, Sept.-Oct. 1859] I collected one or two specimens of every bird I could get. As I had not time to prepare their skins, I packed them in alcohol. *There is only one species of land bird, and this I never saw but obtained one of its tail feathers which I send you. I think it is a species of Hawk.*" (Italics are mine.) Unfortunately this feather cannot be found. Two species of migrant hawks have been reported from the Palau Island; possibly a stray bird reached Apaiang.

Andrew Garrett was an excellent naturalist; Barbour has called him "an extraordinary genius." Although his interests were centered upon fishes and shells, he knew birds. In a contemporary list of birds, mammals of Hawaii, sent to the Museum of Comparative Zoology, he says, (no.) "7 — Phaethon — This fine bird builds its nests and roosts among the precipices bordering the sea in Hamakua and Hilo." He

then describes the bird accurately. And again, (no.) "3 — Fulica — common about our fresh water ponds." It is quite unlikely that he would consider *Tricholimnas* to be a sea bird. Nor is it likely that he would mistake the short, decomposed tail feather of *Tricholimnas* for that of a hawk.

Unfortunately there is no record of the actual provenance of the specimen but the weight of evidence points to its having come from Lord Howe Id. It is probable that it found its way into Andrew Garrett's collection by an exchange, or perhaps through the good offices of a whaling friend.

Further questions occur. Assuming that the type was a member of a population which had for some time inhabited Apaiang Atoll, why was it not found by the contemporaries of Garrett? The answer is that none of them visited the island. However, Kubary, Finsch and others did land upon islands of neighboring groups and no such specimen was recorded. No bird even faintly resembling this has ever been recorded except from Lord Howe Id. and New Caledonia. If the assumption is correct, we must presuppose that wind born or ship born individuals reached Apaiang and no other neighboring islands and that the population was extirpated a very short time after Garrett visited there. It would be strange if such a population had established itself on this flat, almost desert, island in view of the fact that its unmistakable relatives prefer forests and hills and that the intervening islands afford more suitable habitat. That it became extinct in a number of island groups during the twenty years 1860–1880 is not at all probable.

Granted that no proof can be offered and that at best we are dealing with probabilities, the best calculated guess would appear to be that the type of *Tricholimnas conditicius* came from Lord Howe Id.

No specimens of *sylvestris* were to be found in the United States in 1928 when *conditicius* was described. Comparison of the type with a series of twelve in the Rothschild collection, now in the American Museum of Natural History, New York, cause most of the characters ascribed to geographical variation to disappear. The paler crown, throat and underparts, the browner head and throat are doubtless the result of long immersion in alcohol and it is surprising that more color change has not taken place. The only differences are then the length of wing and bill, which are two millimeters shorter than those of the smallest female of *sylvestris* available. Since G. M. Allen, in the original description indicated that the skeleton was obviously that of

an immature bird, perhaps it may reasonably be assumed that this character is due to age.

Measurements, in millimeters, are as follows:

	"conditicius"	*sylvestris*		*lafresnayanus*
		♂	♀	
Wing	132	135–139	133–142	185
Tail	58	58–63	61–65	109
Bill	45	54–56	47–50	52
Tarsus	47	47–50	43–48	54

In the original description the length of the tail of the type of *conditicius* is said to be 68 mm. Mr. Peters agrees with me that it should read 58 mm.

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Museum of Comparative Zoology

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CONTRIBUTIONS TOWARD A RECLASSIFICATION OF THE FORMICIDAE

I. *Tribe Platythyreini* (*Hymenoptera*)

BY WILLIAM L. BROWN, JR.

Museum of Comparative Zoology
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The tribe Platythyreini has included the sole genus *Platythyrea* Roger as treated by former authors. My own investigations show that three additional genera (*Probolomyrmex*, *Escherichia* and *Eubothroponera*) must be included. *Probolomyrmex* Mayr and *Escherichia* Forel have heretofore been placed among the Proceratiini because of their depigmented condition, atrophied eyes (workers), and especially their vertical, fused and approximated frontal carinae and the closeness of the antennal insertions to the median line and to one another, accompanied by fusion of frontal carinae with the greatly crowded clypeus. Also, these two genera have, according to the describers of the included species, only one tibial spur to each of the two posterior pairs of tibiae. I believe that all of the characters just mentioned are correlated with adaptation of the insects to hypogaeic or other cryptobiotic conditions of life; they appear in widely separated genera of ants and other hymenopters, such as *Proceratium*, *Discothyrea* and others in the Formicidae, *Psilobethylus*, etc. in the Bethylidae, and so on, as rather consistent combinations. The similar modifications of doryline and some other ants may be partly due to hypogaeic or subhypogaeic adaptation, but it would seem that the legionary habit may somehow be more important in accounting for this particular structural modification.

For our present purposes, it will be sufficient merely to recognize two facts: (1) the characters combining to produce the "proceratiine

habitus" can and do act to form similar-appearing groups of genera, even though these genera may have the most diverse ancestry; (2) the number and condition of the spurs of the two posterior pairs of tibiae have been found to possess much less taxonomic value than Emery and Wheeler granted in their widely-used keys; in fact, the spurs are now known to be present as pairs, single units, or even to be absent in different species of the same genera in tribes where once the spurs were considered universally constant and tribally diagnostic.

With these facts in mind, one can proceed at once to a more natural classification of the genera and tribes of Ponerinae. *Probolomyrmex* and *Escherichia* have always seemed anomalous as members of the Proceratiini, and they are not, in fact, at all closely related to any other proceratiine genus. Following a slight clue dropped by Mann in 1923, when he mentioned the similarity of the pilosity and sculpture between his *Probolomyrmex boliviensis* and the species of *Platythyrea*, I have carefully compared the two last-named genera and find that they agree in an astoundingly complete way. In fact, the point-by-point agreement is so close that I must consider *Probolomyrmex* to represent a direct derivative of *Platythyrea* modified for a highly cryptobiotic existence in the same way, as I also believe, that the proceratiines are only modified ectatommines. If *Platythyrea* and *Probolomyrmex* are to be associated, then *Escherichia* should probably go along with them. While I have never seen an example of the latter genus, it appears from all accounts to be very close to *Probolomyrmex*, and may even be synonymous and representative of an ergatoid or other intermediate female caste of one of the Ethiopian *Probolomyrmex* species.

A fourth genus that must be included in the Platythyreini is *Eubothroponera*, in spite of its unfortunate name. In his original diagnosis of this Australian group, Clark stated, " . . . certainly close to *Bothroponera* Mayr;" he called the tarsal claws "simple" and gave the palpal formula as maxillary 4, labial 2 segments. I have examined types (Museum of Comparative Zoology) of all the *Eubothroponera* species described to date except *E. brunnipes* Clark, and find that all species, at least in the worker caste, possess single, small but distinct median teeth on all tarsal claws. The palpi in this genus are unusually long for a ponerine group, and the maxillary pair may reach the foraminal border behind if fully outstretched. Most of the few specimens available were inconveniently situated or else had the maxillae retracted, but in spite of this it is clear that all six species seen have more of both maxillary and labial palpal segments than Clark claims

for them. In *E. reticulata* Clark and *E. tasmaniensis* (Forel), a full count was made under good conditions, and in these species the formula was maxillary palpi 6, labial palpi 4 segments. The basal segment, especially in the maxillary palpus, is short, fairly broad, and the segment most likely to be overlooked. Comparing the proportions of the visible segments of the palpi of the less favorably situated specimens with those upon which a direct count could be made, I feel quite safe in assuming that the six species I have seen all possess a 6, 4 formula in the worker.

Now this formula is the primitive one in *Platythyrea*, as I can confirm (*vide infra*), and since all other characters save one combine to link the two genera, they must at least be placed in the same tribe. In fact, the characters separating them are relatively minor ones, though constant and consistent in combination in the series before me. The body in *Eubothroponera* is smaller and generally more compact (less slender and elongate), and the characteristic sculpture of *Platythyrea* is less well developed in *Eubothroponera*, but still basically the same on head and alitrunk. The pilosity must be used to separate the two genera until a study can be made including all castes of a large number of species belonging to both (see key, below).

In examining the palpi of some representative species of *Platythyrea* for this work, it was confirmed, as has been long known, that certain of them have a palpal formula of 6, 4. What is not so generally known, or perhaps even unknown until now, is that certain species of the Old World tropics possess lesser numbers of segments. The New World species *P. angusta* Forel and *P. strenua* Wheeler and Mann have elongate palpi, with the 6, 4 segmentation; the basal segment, particularly of the maxillary palpi, is very short, and the total similarity of the palpi to those of *Eubothroponera* is very striking. Among the Old World forms, *P. cribrinodis* (Gerstaecker) very definitely has short palpi, formula 3, 2. In *P. schultzei* Forel, the maxillary palpi have 2 clearly visible segments each, and there may possibly be a third small basal one, though no third segment could be seen in the single specimen examined; the labial palpi are definitely 2-segmented. Other species, such as *P. sagei* Forel, were not advantageously placed for a definite palpal count, but had short palpi with formulae almost certainly under those of *angusta* for both pairs. Also seen in one doubtfully determined species from the Old World were palpi with definite counts of 6 and 4, but very short in overall proportions. It seems that *Platythyrea* species vary considerably from one to the next in palpal characters, and anyone possessing the material needed for a thorough survey of

the group by means of dissection may be able to correlate this variation with other characters, and thereby be able to recognize more than one group or genus among the array of *Platythyrea* species.

Furthermore, the males of *Platythyrea* seem, from external examination only, to have very distinctive terminalia worthy of further study.

Key to the genera of the tribe Platythyreini, based on the workers and probably applicable to the females

1. Frontal carinae and clypeus fused and projecting anteriorly over the mandibles; antennae somewhat incrassate apically, inserted close together on the anterior part of the clypeo-carinal process. (Small, usually pale-colored forms, under 4 mm. in length. Ethiopian, Neotropical, Indo-Australian) ..... *Probolomyrmex* Mayr[1]
   Escherichia Forel

   Frontal carinae and clypeus not projecting anteriorly over mandibles; antennae inserted distinctly posterior to the clypeus and apart from one another, the insertions covered by the broad lobes of the frontal carinae, funiculus not or scarcely incrassate in most forms. (Larger, usually pigmented forms, mostly over 4 mm. in length) 2
2. Distinct erect pilosity present and widely distributed (widespread in Australia) ..... *Eubothroponera* Clark

   Distinct erect pilosity limited to mouthparts and gastric apex. (Tropicopolitan; occurring naturally or as tramp species in some warm temperate regions) ..... *Platythyrea* Roger

Below are listed the platythyreine genera as known to me at present, and also a citation of the genotypes and the principal references to the literature. The references are not intended to be complete, but are designed to give the interested worker a start toward the gathering of pertinent titles.

Platythyrea Roger

1863, Berlin. Ent. Zeitschr., **7**: 172. Genotype: *Pachycondyla punctata* Fred. Smith, 1858, soldier (*recte* worker), male; designated by Bingham, 1903.

Besides the characters cited in the key (above), it should be mentioned that this genus, and also *Eubothroponera*, are further marked by

[1] *Probolomyrmex* and *Escherichia* are supposed to differ in that the latter has small compound eyes and a discernible postmesonotal groove or line, but it is important to note that Forel himself, in the original description of *Escherichia*, compared the novelty with several proceratiine genera, but made no mention of *Probolomyrmex*! Certain *Probolomyrmex* (*P. boliviensis* Mann, *P. parvus* Weber) are known only from the female caste.

having a complete and apparently functionally flexible suture separating the pro- and mesonotum, and also by having a large and a smaller spur on each one of the two posterior pairs of tibiae.

Emery's survey of the world species (1911, Gen. Ins., Fasc. 118, pp. 28–30) is comprehensive for its time, but is now far out of date due to the addition of many forms since it was written. Wheeler's "Ants of the Belgian Congo" (1922, Bull. Amer. Mus. Nat. Hist., **45:** 57–60, 758–761, 1007) gives references to African and Malagasy species.

Eubothroponera Clark

1930, Proc. R. Soc. Victoria, Melbourne, (n.s.) **43:** 8–9. *Genotype: Eubothroponera dentinodis* Clark, 1930, worker; original designation, *nec E. tasmaniensis* (Forel) designated by Clark in 1934.

With the original generic description, Clark characterized and figured three species (pp. 9–11, fig. 1): *E. dentinodis* Clark (p. 9, fig. 1, nos. 6, 6a); *E. micans* Clark (p. 10, fig. 1, nos. 7, 7a); *E. bicolor* Clark (p. 11, fig. 1, nos. 8, 8a); he also included in the genus Forel's *Pachycondyla* (*Bothroponera*) *tasmaniensis* (p. 11), and gave a "key" (p. 9) to the three Western Australian species newly described.

In 1934 (Mem. Nat. Mus., Melbourne, No. 8, pp. 32–34, pl. 2, figs. 15–17) Clark redescribed the worker of *E. tasmaniensis* (Forel) (p. 32, fig. 15) from Tasmania and described the new species *E. reticulata* (p. 33, fig. 16) from New South Wales and *E. septentrionalis* (p. 34, fig. 17) from Queensland.

A seventh and last species was added by Clark when he described *E. brunnipes* (1938, Proc. R. Soc. Victoria, Melbourne, **50:** 361–362, fig. 3) from Reevesby Island, Sir Joseph Banks Group, South Australia (biology, *loc. cit.*, p. 356).

The above, I think, includes all the recognized species of *Eubothroponera*, each reported only from the worker caste. The species are quite uniform in structure, and it is felt that Clark has failed in some instances to properly differentiate them; consequently, a review of the genus is necessary.

Probolomyrmex Mayr

1901, Ann. Naturhist. Hofmus. Wien, **16**: 2–3. Genotype: *Probolomyrmex filiformis* Mayr, 1901, worker; monobasic.

M. R. Smith (1949, Proc. Ent. Soc. Washington, **51**: 38–40) has reviewed briefly the five species known to that date. A sixth species was described at about the same time by Weber (*P. parvus* Weber, 1949, Amer. Mus. Novit., No. 1398, pp. 3–4, fig. 2, female) from Africa. A description with a good habitus drawing of the female type of *P. boliviensis* is given in the original reference by Mann (1923, Psyche, **30**: 16–18, fig. 2). A seventh species, apparently remaining undescribed, has been taken in the Canberra region of eastern Australia by Mr. Tom Greaves.

Escherichia Forel

1910, Zool. Jahrb. Syst., **29**: 245–246. Genotype: *Escherichia brevirostris* Forel, 1910, *op. cit.*, pp. 246–247, worker; monobasic.

Although there are entries in the catalogs of Emery and Wheeler, this genus and species seems not to have been reported a second time. It should be noted, however, that Weber's description of *Probolomyrmex parvus*, cited above, may just possibly apply to the female of *Escherichia brevirostris* when the latter becomes known in association with workers, as the characters and type localities given for the two species do not, to my mind, exclude the possibility of conspecificity.

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Museum of Comparative Zoology

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ON THE NOMENCLATURE OF THE PACIFIC GRAY WHALE

BY WILLIAM E. SCHEVILL[1]

The gray whale of the Pacific has until recently been called *Rhachianectes glaucus* (Cope). In 1937 van Deinse and Junge published an important paper of which the main part is a thorough comparative study of subfossil *Eschrichtius robustus* bones from the Netherlands, comprising one adult cranium and two juvenile crania, one of which was associated with the mandibles, scapulae, and other parts of the skeleton. These they compared with an adult *Rhachianectes glaucus* skeleton in the British Museum, as well as with the published material on both forms. Although the subfossil bones are naturally worn and fragmentary, as well as being for the most part juvenile, they present ample characters to indicate that they and the gray whale are congeneric. At this point I would like to emphasize that the following criticisms of van Deinse and Junge's conclusions are directed solely at their taxonomy; this involves no disparagement of their important and valuable osteological work, which has demonstrated the generic identity of *Eschrichtius* Gray 1864 and *Rhachianectes* Cope 1869 (= *Agaphelus* Cope 1868). But they also argue for specific identity, and thus unite *Rhachianectes glaucus* (Cope) 1868 with *Eschrichtius robustus* (Lilljeborg) 1861. Moreover, they argue that Dudley's scrag whale (1725), named *Balaena gibbosa* by Erxleben (1777, p. 610), is the same form, and therefore say (1937, p. 181), "After this it is clear that the name of this whale must be changed into *Eschrichtius gibbosus* (Erxleben). We must emphasize that with the bones we have now at hand we cannot give any argument that the Pacific and Atlantic representatives of *Eschrichtius* should be specifically different." But by the same token these bones cannot prove that these whales are specifically identical.

[1] Contribution No. 626 of the Woods Hole Oceanographic Institution.

Additional and better material of *E. robustus* may present more specific characters, but until such material turns up, it seems unfortunate to take a well-grounded name of a well-characterized living form, known from complete specimens, and replace it with that of a form so imperfectly known from such incomplete material that specific characters cannot be entirely established; instead it seems better not to change the name of the well-known form.

It is even less desirable to use the name (*gibbosa* Erxleben) of a form which from the beginning has been an unrecognizable literary curiosity. Considering the available information, which is scanty though oft repeated, the most that can be said for *Balaena gibbosa* Erxleben is that it may be an *Eschrichtius*, but since it is not specifically well characterized and since nothing sufficiently like it has ever again been reported from anywhere near the type locality ("the Coast of New England") or elsewhere in the Atlantic, it seems to be stretching probability to submerge in it known forms from other regions. Detailed consideration of the uncertainties in attempting to identify Dudley's scrag whale (*Balaena gibbosa* Erxleben) are omitted here. From time to time cetologists have tried to identify this beast, but have always been frustrated by various irreconcilable data, the chief of which is perhaps the utter lack of specimens. Cope's attempt to embody *gibbosa* Erxleben was undermined by his confusion over a dilapidated specimen of *Balaenoptera acuto-rostrata*, so that he formally withdrew in 1884 (p. 1124). Although he did not publish details, it is probable that Cope used much the same reasoning as van Deinse and Junge in associating Dudley's scrag and the Pacific gray whale in the same genus. Thus it appears best to continue to use *robusta* Lilljeborg for the subfossil European form.

As to the nomenclature of the Pacific gray whale, it seems reasonable to retain the trivial name *glaucus* until better material of *Eschrichtius robustus* may demonstrate specific identity (although Cederlund (1939, p. 282) believes the holotype sufficient for this). It is therefore suggested that the living Pacific gray whale be called *Eschrichtius glaucus* (Cope).

This status may be summarized thus:

Genus

Eschrichtius Gray 1864 (p. 350). Type species (by subsequent designation by Lilljeborg 1865, p. 494): *Balaenoptera robusta* Lilljeborg 1861.

Species

Eschrichtius robustus (Lilljeborg)

Balaenoptera robusta Lilljeborg 1861, p. 602.

The Gräsö whale.

Subfossil in northwestern Europe (English Channel to Baltic Sea).

Eschrichtius glaucus (Cope)
Agaphelus glaucus Cope 1868a, p. 160, 1868b, p. 225.
Rhachianectes glaucus Cope 1869, p. 15.
The California or Pacific gray whale; devilfish.
Recent in North Pacific Ocean (Baja California to Korea).

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A NEW SPECIES OF THE CYCLOSTOME GENUS *PARAMYXINE* FROM THE GULF OF MEXICO

BY HENRY B. BIGELOW and WILLIAM C. SCHROEDER[1]

Up to the present time the myxinids, represented in the North Atlantic by the unibranchiate genus *Myxine* alone, have been unknown in the Gulf of Mexico. During 1951, however, the experimental trawlings of the U. S. Fish and Wildlife Service vessel "Oregon", in the northern part of the Gulf, yielded three specimens of a myxinid with six pairs of external gill openings that agree closely with the genus *Paramyxine* Dean 1904, reported previously from Japan only.[2] *Paramyxine*, originally described from a single specimen, as the new species *P. atami* Dean 1904, is characterized, by its author, by having the outer "branchial ducts of distinctly unequal length, the most anterior several times the length of the posterior" (Dean, p. 22), so that the most anterior pair of external gill openings is opposite the 4th or 5th pair of internal gill sacs; and by having the successive pairs of gill openings close together. In other known myxinids with more than one pair of gill openings the successive pairs of external branchial ducts are of approximately equal lengths, or the 1st pair is only a little longer than the rearmost pair, and the successive pairs of gill openings are more widely spaced. On the type specimen the gill openings themselves were oval, with their long axes transverse (except for the 6th opening on the left-hand side, which — receiving the oesophageal duct — is larger than the others), not round as they are in other polybranchiate species. But the gill openings were of various shapes in other specimens described subsequently by Matsubara (1937), showing that their shape is not a generic character as Dean supposed,

[1] Contribution No. 610, from the Woods Hole Oceanographic Institution.

[2] We owe to Mr. Stewart Springer the opportunity of studying these interesting specimens.

or even a specific character, but is, likely, dependent to a considerable extent on the degree of muscular contraction. This leaves only the relative lengths of the external branchial ducts and perhaps the close spacing of the gill openings, as compared with other myxinids in which they are few in number, as bases for separating the genus *Paramyxine* from other polybranchiate myxinids. We accept the genus provisionally, awaiting the opportunity of examining other myxinids with corresponding numbers of gill openings.

Characters that Dean (1904, p. 22) included as specific for *P. atami* were the precise number (6) of pairs of gill openings; 1st pair of external branchial ducts about 3 times as long as the 6th pair; 12 and 13 lingual teeth in the outer rows with 13 in each of the inner rows; anterior 3 lingual teeth of each row fused with one another at their base; white gill openings and conspicuously dark mucous pores. His illustration also shows a rather pointed snout, resembling that of *Myxine*, but a somewhat broader and more paddle-shaped caudal fin fold.

The gill openings of the type specimen of *atami* occupied a space about 9 per cent as long as the distance from the tip of the snout to the most posterior pair of gill openings,[1] with those on each side arranged close together in a regular row, and they are arranged similarly in an excellent specimen of *atami*, from Suruga Gulf, Japan, received recently by the U. S. National Museum (U. S. Nat. Mus. No. 161442). But Matsubara's (1937) observations have shown that the serial arrangement of the gill openings, like their shapes, may vary widely from individual to individual, and even between the two sides of the body of a given specimen, for they were irregularly arranged in 13 of his 14 specimens. Muscular contraction may play a role here. Matsubara also found that the dental formula is not a precise one, for his specimens had only 10 or 11 lingual teeth in each row, outer and inner, with only the first two fused at the base instead of three as was true of the type specimen.

The Gulf of Mexico specimens agree in general with the accounts and illustrations of the Japanese *atami* and with the National Museum specimen, in body form, with rather pointed snout and a caudal fin fold somewhat wider than that of *Myxine*. Their barbels are similar to those of *atami* in length and in arrangement; they have the same number (6 pairs) of external gill openings; the external branchial ducts (as measured by probing) are about as long relative to the 6th pair;

[1] As scaled from Dean's (1904, pl. 1, fig. 3) illustration.

the foremost pair is situated about as far rearward while the gill openings cover about as long a space relatively; the distribution of mucous pores is about the same; also the linear dimensions in general, as appears from the following tabulations:

Table 1

Distances, in Per Cent of Total Length

	Gulf of Mexico specimens, 338, 055 and 590 mm.	*atami*, Japan type 550 mm.	*atami*, U. S. Nat. Mus. specimen 500 mm.
Snout to foremost mucous pore	7.5– 8.7	6.8	9.0
Snout to foremost gill openings	22.5–23.5	26.0	27.0
1st gill opening to 6th gill opening	2.4– 5.7	2.5	2.4
6th gill opening to tip of caudal fin fold	72.0–74.3	71.4	73.0
Snout to origin of anal fin fold	37.1–50.0	41.4	43.4
Cloacal pocket (center) to tip of caudal fin fold	13.4–17.5	12.8	13.2

Table 2

Numbers of Mucous Pores on Each Side

	Gulf of Mexico specimens	*atami*, type[1]	*atami*, U. S. Nat. Mus. specimen
Snout to foremost pair of gill openings	15-15 to 19-19	19–20	16–16
6th pair of gill openings to cloacal pocket	44-45 to 57-57	58–59	47–47
Center of cloacal pocket to tip of caudal fin fold	11-11 to 13-14	?	10–10

The number of lingual teeth, too, is about the same in a Gulf of Mexico specimen of 505 mm. (14 and 13 in the outer rows, 11 and 12 in the inner rows) as it was in the type specimen of *atami*, with the same number (3) of anterior teeth fused basally in each of the outer two rows. And while two only, of the anterior teeth in each of the inner rows are fused in the Gulf of Mexico specimen, three were fused in the type, and Matsubara (1937, p. 15, text fig. 3) has already reported and figured Japanese specimens that agreed with the Gulf of

[1] From Dean 1904, p. 11, text fig. 2, D.

Mexico one in this respect. The series of mucous pores on each side is interrupted near the anterior end of the cloacal pocket on the U. S. National Museum specimen of *atami* (Fig. 6), just as it is in the Gulf of Mexico specimens (Fig. 5) — in *Myxine* too, for that matter — to continue rearward at a higher level. Representation of it in Dean's (1904,pl. 1, fig. 3) illustration as continuing unbroken past the cloacal pocket seems to have been an error by the artist. But the rearward pores are situated higher above the ventral edge of the caudal fin fold in the Japanese *atami* (Fig. 6) than in the Gulf of Mexico specimens (Fig. 5).

The depth, too, of the body relative to the distance from tip of snout to 1st pair of external gill openings is greater on all three of the Gulf of Mexico specimens (34 per cent to 37 per cent) than is pictured for *atami* either by Dean (30 per cent) or by Matsubara (22 per cent), or than it is on the U. S. National Museum specimen of *atami* (29 per cent). And while the hagfishes are so soft of body that measurements of different specimens cannot be accepted as precisely comparative unless taken under equal tension, the difference in this respect between the two geographic populations may be large enough to be significant. The shape of the caudal fin fold also differs rather noticeably, its lower margin being nearly straight in all three of the Gulf of Mexico specimens while it is pictured as moderately convex in the two Japanese specimens of *atami* which have been illustrated (Dean 1904, pl. 1, fig. 3; Matsubara 1937, pl. 1, fig. A), likewise in the National Museum specimen of *atami* (compare Fig. 5 with Fig. 6).

Furthermore, neither of the two larger Gulf of Mexico specimens shows any trace of a dorsal fin fold anterior to the level of the cloacal pocket, whereas Matsubara's (1937, pl. 1, fig. A) illustration of *atami* clearly shows such a fold, extending forward for one third to one half the distance from the level of the cloacal pocket toward the level of the 6th pair of gill openings while the dorsal fin fold on the National Museum specimen of *atami* is continued forward as a definite though low dermal ridge to abreast of the 6th pair of gill openings.[1]

These differences between the Gulf of Mexican and the Japanese representatives of the genus seem sufficient, in combination, for recognition in nomenclature. We therefore propose for the former the new specific name *springeri*, as defined below. What is most interesting, however, in this case, is not that the Gulf of Mexican population

[1] The anal fin fold also, of the National Museum specimen of *atami* is continued forward nearly to the 6th gill opening as a prominent dermal ridge. But the appearance of the latter, in alcohol, suggests that it was the result of aulmuscr contraction, not a normal characteristic.

differs in minor ways from the Japanese — it would be astonishing if such were not the case — but that two populations so widely separated should resemble each other so very closely, and that myxinids with five to seven pairs of external gill openings should have been found at localities as widely separated as the Gulf of Mexico, Japan and China, New Zealand and South Africa, but nowhere else in the oceans.[1] This instance does not stand alone as it concerns the Gulf, for the chimaeroid *Hydrolagus alberti* Bigelow and Schroeder 1951*a*, recently discovered in deep water there, seems more closely allied to the Japanese *H. mitsukurii* (Dean) 1904, than it is to either of the two species of its genus that are known from the North Atlantic, i.e., *affinis* (Brito Capello) 1868, and *mirabilis* (Collett) 1904, or than it is to *H. collei* (Lay and Bennett) 1839, of the Pacific coast of North America. Equally unexpected was the recent discovery, in the Gulf, in moderately deep water, of a representative (*Springeria folirostris* Bigelow and Schroeder 1951), of the rajoid family Anacanthobatidae, for the latter had been known before only off the Natal coast of southeast Africa; also of two representatives of the skate genus *Cruriraja* in Cuban-Floridan waters (*C. atlantis* and *C. poeyi* Bigelow and Schroeder 1948), for this genus, too, had been known only off Natal, southeast Africa, previously.

Altogether, the bottom zone in the Gulf and around Cuba at 75 to 600 fathoms has yielded three new species of sharks, eleven new batoids, and one new chimaeroid since 1938, a foretaste of the rich harvest of unknown fishes to be expected from a more thorough exploration of the deep slopes and of the sea floors of the Gulf and of the Caribbean.

Paramyxine springeri, new species[2]

Type. A specimen, 590 mm. long, Oregon Station No. 489, Lat. 27°44′N., Long. 85°09′W., 254 fathoms, Sept. 29, 1951 (U. S. Nat. Mus. No. 161512).

Additional material. Another specimen 505 mm. long from the same trawl haul, and a third, 338 mm. long, from Oregon Station No. 321, Lat. 27°27′N., Long. 87°19′W., 220 fathoms, April 28, 1951. The sex has not been determined for any of these specimens.

Description. Dimensions, in per cent of total length, of type (590 mm.), 505 mm. specimen, and 338 mm. specimen.

Depth of body, at 1st gill openings, 9, 7.8, 8.9.

[1] For a synopsis of the species of myxinids, see Holly, 1933.
[2] Named after Stewart Springer who discovered this interesting cyclostome.

Distance, snout to 1st gill openings, 23.5, 23.2, 22.5.

Distance, 1st gill openings to 6th gill openings, 2.4, 2.6, 5.7.

Distance, snout to origin of anal fin fold, 50.0, 37.1, 39.8.

Distance, center of cloacal pocket to tip of tail, 14.5, 13.4, 17.5.

Depth, in per cent of distance, snout to 1st gill openings, 38, 34, 37.

Number of mucous pores on each side, type (590 mm.), 505 mm. specimen and 338 mm. specimen:

Snout to 1st gill openings, 19-19, 18-18, 15-15.

1st gill openings to 6th gill openings, 4-3, 3-3, 6-6.

6th gill openings to anterior end of cloacal pocket, 55-56, 57-57, 44-45.

Anterior end of cloacal pocket to tip of caudal fin fold, 13-14, 11-11, 12-12.

Snout obtuse-conical, much as in *Myxine*; body cylindrical anteriorly, about 80 to 100 per cent as thick (transversely) at region of gill openings as deep there, but increasingly compressed posteriorly, until only about 38 to 54 per cent as thick as deep at level of cloacal pocket, and flat sided thence rearward to paper-thin margin of caudal fin fold. Depth of body about 5.4 to 6 per cent as great as total length at level of most anterior mucous pores, about 6.3 per cent at anterior end of cloacal pocket on type, and 6.6 to 8.6 per cent on smaller specimens.

Fleshy rostrum, anterior to nasal opening, broadly rounded anteriorly and wider than long,[1] the nasal opening conspicuous below it. Barbels in the typical myxinid arrangement, the 1st pair about two-thirds as long as the 2nd pair, the 3rd pair a little the longest. Mouth, when closed, with the usual puckered or irregularly stellate appearance, the conical projection that flanks it on either side about as long as the 2nd pair of barbels. Thirteen and fourteen lingual teeth in the outer rows, eleven and twelve in the inner rows of 505 mm. specimen[2], individual teeth conical with slightly blunted tips, curving a little rearward, the most posterior of each inner row strongly so; the 5th and 6th tooth longest in each row; the 7th and the following teeth successively shorter along each row; the rearmost only about one-third as long as the 5th and 6th. The first three teeth in each outer row, and the first two in each inner row fused at their bases; the outer row in each side about 1.2 times as long as the inner row; the longest teeth in the outer rows about 1.3 times as long as the longest in the inner rows.

[1] Longer than wide in *Myxine*.

[2] The teeth of the type specimen cannot be counted without dissection.

The six pairs of gill openings are low down on the sides, their fore-aft position as given in Table 1 (p. 3), occupying a shorter space on larger specimens (2.4 per cent of total length on the type) than on smaller, the series on the two sides converging rearward, with the 6th pair only about three-fourths as far apart as the 1st pair on the type, about four-fifths as far apart on the smallest specimen; the 6th opening on the left-hand side (receiving the oesophageal duct) larger than the others as is the rule among myxinids, and irregular in shape, the other gill openings ranging in shape from round to oval with the long axis transverse or slightly oblique, the precise shape seemingly dependent on muscular contraction; the largest (apart from the 6th left-hand) a little less than one-half as long as the 3rd (longest) pair of barbels. The gill openings are either in regular serial arrangement on each side as on the type (Fig. 2) and on the smallest specimen, or more or less irregular at least on one side, as on the 505 mm. specimen (Fig. 3), a difference perhaps associated with muscular contraction. The 1st pair of external branchial ducts (as sounded by probing, on one side of the body) are about three times as long as the 6th pair, both on the type and on the 505 mm. specimen.

The mucous pores range in size from easily visible to so minute as to be discernible only on close examination. Their location on the body and in serial arrangement is as in the other myxinids; 19 pores on each side from snout to 1st gill openings on the type, 4 on one side and 3 on the other abreast the gill openings, 55 and 56 between gill openings and cloacal pocket and 13 and 14 rearward from the anterior end of the cloacal pocket on the type specimen; their numbers on the other specimens as given in Table 2 (p. 3). Totals of 77 pores on the 338 mm. specimen, of 88 on the 505 mm. specimen, and 92 on the 590 mm. specimen (type) show that the pores increase in number with growth. The pores along the section occupied by the gill openings are ventral from the latter, which it seems is characteristic of the polybranchiate myxinids in general.

The pores rearward from the gill openings are nearly in line with the latter, are low down on the sides nearly to the anterior end of the slit-like cloacal pocket, where the series is interrupted, with the nine posterior pores situated at a definitely higher level, a distinctive character of this species as contrasted with the Japanese *atami* (p. 4). On the type, those rearward from the cloacal pocket are also noticeably larger (hence more conspicuous) than those farther forward, and they are somewhat more conspicuous than the more anterior pores on the

505 mm. specimen as well. But this regional difference in size of mucous pores is not a specific character; rather it is likely a phase of muscular contraction, for the pores of the caudal series on the smallest specimen are no larger than those anterior to the cloacal pocket.

The point of origin of the anal fin fold, about midway of the body on the type specimen, is considerably farther forward on the other two specimens (see Table 1, p. 3) showing that its precise situation is variable within rather wide limits. On the type, the fold itself is so narrow that its width is hardly measurable, and it is traceable rearward only about half the way from its point of origin toward the cloacal pocket. But it is wider on the other specimens (8 to 13 per cent as wide as the body is deep), and traceable rearward nearly or quite to the cloaca. To what degree these differences are associated with different stages in growth, or in the sexual cycle, is a question for the future.

Neither the type, nor the 505 mm. specimen shows any trace of a dorsal fin fold anterior to the level of the cloacal pocket, their backs being evenly rounded, in which respect they contrast with *P. atami* as pictured by Matsubara (1937, pl. 1, fig. A). And while the smallest (338 mm.) specimen has a low fleshy ridge all along the back nearly to the level of the mouth, the fact that it is flanked on either side by a shallow and indefinite furrow suggests that it is the result of muscular contraction, rather than a definite and persisting fin fold. The caudal fin fold fringes the rear section of the trunk, from about opposite the anterior end of the cloacal pocket on the dorsal side, around to the posterior end of the cloaca on the ventral side. Its lower outline is nearly straight as remarked above (p. 4). The irregular fluting of its broadly rounded, posterior-dorsal margin on the smallest specimen (Fig. 5) seems to represent its normal outline better than its margin on the type, (Fig. 1) where it seems to have been injured.

One of the most interesting features of *P. springeri*, reported to us by its discoverer, is that no one of the specimens discharged any mucus at all when brought on board, or so little that none was noticed.

Color. All three specimens are greyish brown, faintly tinged with reddish, below as well as above, the edges of the caudal fin fold and of the anal fin paler; the gill openings encircled with white, rendering them conspicuous against the dark background; the mucous pores appearing as dark brown dots, each of them at the bottom of a shallow depression of the skin.

Size. The maximum size is not known.

Range and habits. So far known only from the northern side of the Gulf of Mexico, at the localities listed on page 5. The depths of capture, added to the fact that fishermen have never reported it, show that it is a deep-water species. Nothing else is known of its habits.

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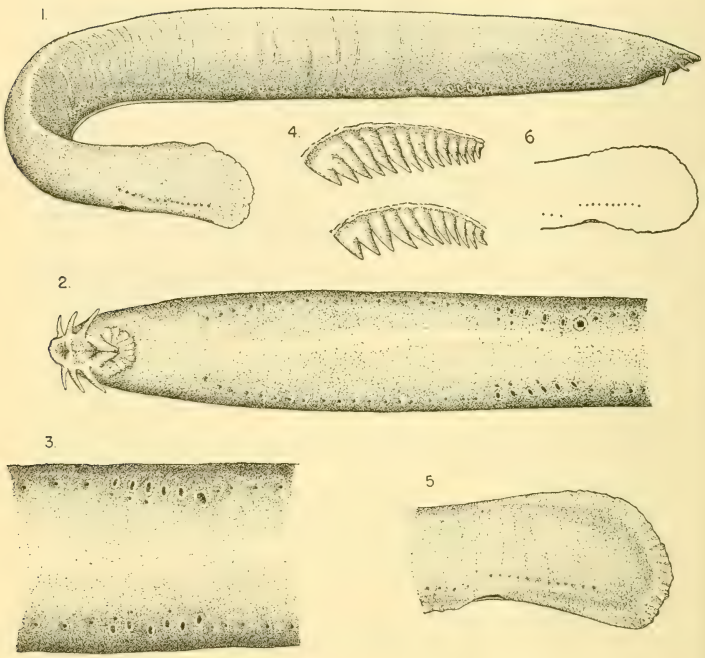

Fig. 1. Type specimen, x ¼; the mucous pores somewhat exaggerated.

Fig. 2. Ventral view of anterior part of type specimen, x ½; the mucous pores somewhat exaggerated.

Fig. 3. Ventral view of gill region of specimen 505 mm. long; natural size; the mucous pores somewhat exaggerated.

Fig. 4. Lingual teeth of specimen 505 mm. long, from the right-hand side; outer row above, inner row below, anterior ends to the left, x 2.

Fig. 5. Side view of caudal region of specimen 338 mm. long, x ½; the mucous pores slightly emphasized.

Fig. 6. Side view of caudal region of *P. atami*, 500 mm. long, from Suruga Gulf, Japan, U.S. Nat. Mus., No. 161442; the mucous pores slightly emphasized.

BREVIORA

Museum of Comparative Zoology

CAMBRIDGE, MASS. OCTOBER 21, 1952 NUMBER 9

NEW SPECIES OF EARTHWORMS FROM THE ARNOLD ARBORETUM, BOSTON

BY G. E. GATES

I.

From *Allolobophora caliginosa* (Savigny) 1826 there have recently been split off: *A. nocturna* Evans 1946, and *A. iowana* Evans 1948. The new species were thought to be distinguished by differences in location of first dorsal pore, extent of male porophores, etc., and especially by number of segments. These characteristics had not previously been given such weight in lumbricid taxonomy, may be subject to variation and, as in the case of segment number, may be tedious to use when dealing with large numbers of worms.

While working on collections from the Arnold Arboretum and other localities near Boston, it was found that material with characteristic *caliginosa* tubercula pubertates could be rapidly sorted into two groups according to the presence or absence of genital tumescences on segment xxxiii. Further study showed that those specimens with tumescences on xxxiii were referable to *caliginosa* as apparently restricted by Evans after breeding the worms in the laboratory. The worms with no tumescences on xxxiii were found to be consistently distinguishable from *caliginosa* by the same sort of characteristics as in the case of *nocturna* and *iowana* and, as well as those species, worthy of specific status.

ALLOLOBOPHORA ARNOLDI n. sp.

Type. Museum of Comparative Zoology, cat. no. 4441.

Length, 55–100 mm., diameter, 4–6 mm. Segments, 152–194 (normal specimens). Unpigmented and almost white, or of greyish appearance or, especially in older worms of second season, with a brownish coloration. First dorsal pore, on 10/11, 11/12, or 12/13. Clitellum, on xxvii, ½xxvii, or xxviii to xxxiv or ½xxxv. Tubercula

pubertates of double origin, on xxxi xxxiii. Genital tumescences, including *a* and *b* setae, on ix–xi, xxx, xxxii, xxxiv, and occasionally also on xxvi.

Spermathecal pores, on 9/10–10/11 on *c* lines, setae, male porophores, calciferous sacs, calciferous glands, typhlosole and last hearts, etc., as in *caliginosa*.

Type locality. Arnold Arboretum, Boston, Mass.

Distribution. Known at present only from Boston and vicinity.

Remarks. A. arnoldi is distinguished from *caliginosa* by the constant absence of genital tumescences on xxxiii, occasional presence of tumescences on xxvi (instead of xxvii), slightly greater anterior extent of the clitellum (xxvii or xxviii instead of ½xxviii or xxix), greater number of segments, and perhaps by a slightly more anterior first dorsal pore.

From *iowana*, *arnoldi* is distinguished by the constant presence of genital tumescences on xxxiv, constant absence of those tumescences on xxxiii, by the two-part tuberculum about as in *caliginosa*, possibly also by a slightly more posterior first dorsal pore, greater number of segments and absence or slighter development of pigmentation (not dark reddish brown).

From *nocturna*, *arnoldi* is distinguished by the constant absence of tumescences on xxxiii and xii, smaller size, fewer segments, less restricted male porophores, and possibly by a more posterior first dorsal pore.

Data as to variation in both *caliginosa* and *arnoldi* in the Boston area will be presented, if possible, in another contribution.

II.

In lumbricid taxonomy considerable weight has been given in the past to rather small differences in the tubercula pubertates. Thus, for instance, the species in the following pairs have been distinguished from each other by a one-segment homoeosis of the tubercula: *Octolasium cyaneum* (Savigny) 1826 and *O. lacteum* (Örley) 1881, xxx–xxxiii and xxxi–xxxiv; *Lumbricus rubellus* Hoffmeister 1843 and *L. castaneus* (Savigny) 1826, xxviii–xxxi and xxix–xxxii. Further, *Dendrobaena rubida* (Savigny) 1826 has been distinguished from *D. subrubicunda* (Eisen) 1874, by a one segment difference in length of the tubercula, xxix–xxx and xxviii–xxx. Genital tumescences, as indicated above, may also be of considerable value in lumbricid taxonomy.

Accordingly, it seems advisable to treat a worm distinguishable at present from the *caliginosa*-complex only by differences in tubercula

and tumescences as specifically distinct.

ALLOLOBOPHORA MOLITA n. sp?

Type. Museum of Comparative Zoology, cat. no. 4442.

Length, 81 (+ ?) mm., diameter, 5 mm. Segments, 140 (+ ? posterior amputee?). Pigmentation lacking. First dorsal pore in ?12/13. Clitellum on xxviii–xxxiv, possibly reaching slightly onto xxvii. Tubercula pubertates, longitudinally placed bands in *bc*, extending across entire lengths of xxx–xxxiii; with lateral margins nearly smooth, but median margins (quite definitely lateral to *b* lines) slightly indented by 30/31, 31/32, 32/33. Genital tumescences, including *a* and *b* setae, present on ix–xi, xxxii and xxxiii (feebly developed).

Spermathecal pores, male porophores, setae, calciferous sacs and glands, typhlosole, last hearts, as in *caliginosa*.

In the clitellum intersegmental furrows are obliterated and dorsal pores are occluded but the epidermal thickening is slight. Spermathecae (in x and xi) are iridescent and presumably contain spermatozoa obtained from a copulatory partner. Male funnels are iridescent, also indicating sexual maturity in spite of the feeble development of the clitellum.

Remarks. A. molita is distinguished from all of the *caliginosa*-complex: *caliginosa*, *nocturna*, *iowana* and *arnoldi*, by the four-segment tubercula pubertates. Further distinction may be provided by an apparent restriction of genital tumescences in clitellar region to xxxii–xxxiii. From all of the complex, except possibly *iowana*, *molita* is also distinguished by the quadripartite (instead of double) origin of the tubercula. In *iowana*, tubercula are band-like but nothing was said as to origin.

Type locality. Arnold Arboretum, Boston, Mass.

Distribution. At present known only from the type locality.

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BREVIORA

Museum of Comparative Zoology

CAMBRIDGE, MASS. DECEMBER 29, 1952 NUMBER 10

ON THE EARTHWORMS OF NEW HAMPSHIRE

BY G. E. GATES

So far only one record of earthworms in New Hampshire has been encountered in the literature. The worms were found "under the bark of trees" at elevations of 2,000–3,000 feet in the White Mountains by a German delegate to the International Zoological Congress at Boston in 1907. The specimens went to an Irish Museum where they were identified as *Dendrobaena rubida* (Savigny) 1826, by Southern (1910). The species had not previously been reported from North America and since 1910 there has been no further record from this continent. The record was given in a short article on another kind of worm and, though the article was published in Philadelphia, the record was not included in Smith's review (1917) of the Lumbricidae of North America.

Through the kindness of Dr. P. J. Darlington, Jr. who donated the bait remaining from a fishing trip, it is now possible to list a second species for New Hampshire.

Southern (1910, p. 18) quoted his collector who stated that "earthworms were very rarely met with in the forests at elevations of 2,000-3,000 feet." Similar statements have been made in the past with reference to forests of northern New England as well as of northern New York. Accordingly, Dr. Darlington's observations appear to be worthy of record:

"My experience has been that it is always possible to find earthworms in fair numbers even in the heavy woods in the more remote parts of New England, or at least in the White Mts. and the Connecticut lakes districts of New Hampshire. I have looked for them many times when I wanted them for bait for trout and I have always been able to find them under cover along the banks of brooks. I am fairly

sure that there are at least two species. One, . . . (see below) . . . although it occurs on the stream banks, is usually well above the water level under stones or logs or in the roots of vegetation in sandy places that are damp but not wet. The other species is darker and much smaller, in fact hardly large enough to use for bait and it seems to occur in much wetter places, under stones on gravel bars or sandy banks very close to the water level. . . . Practically every brook in New England is fished these days, and many of the fishermen bring worms with them and throw out what may be left at the end of their fishing trips, so that different species must have been introduced many times, even in the deep woods." (Darlington, *in lit.*)

Allolobophora arnoldi Gates 1952

In steep bank of East Inlet Brook, about 2,000 ft. above sea level, near spruce, in heavy but not virgin forest, above Second Connecticut Lake, May 30, 1952. Four clitellate specimens. Dr. P. J. Darlington, Jr. collector.

Length, 95–105 mm. Diameter, 5.5 mm. Segments, 91 (amputee), 106 (amputee), 156, 158. First dorsal pore, ?12/13 (1), ??13/14 (2). Clitellum, ½xxvii-xxxiv. Tubercula pubertates bipartite and as in *A. caliginosa* (Savigny) 1826. Genital tumescences, on ix-xi (4), xxx, xxxii and xxxiv (4), xxix (1).

Remarks. Alive, these worms appeared to be quite without pigment and they looked in that respect much as *Octolasium cyaneum* (Savigny) 1826 usually does.

The epidermis of segments xxvi, anterior half of xxvii, and of xxxv, is somewhat thickened and of a translucent appearance quite distinct from that of normal epidermis as well as from the yellow or white opacity of the clitellar epidermis, on three specimens. The demarcation of opacity and translucence on xxvii is indistinct, one gradually passing into the other, on the fourth worm.

On the last segment of the amputees, rudiments of setal follicles and of nephropores are still recognizable. In one of those specimens the new anal region is small and scarcely distinguishable from the ninety-first segment but probably is demarcated by a quite fine, greyish translucent furrow (presumably a rudimentary intersegmental furrow). In the other amputee no special anal region is recognizably demarcated.

A. arnoldi was split off from *A. caliginosa* when it was found in Boston collections that all specimens having genital tumescences on

xxx, xxxii and xxxiv (with none on xxxiii) could also be distinguished from *caliginosa* by greater clitellar length and by larger segment number.

The presence of worms with *arnoldi* characteristics in northern New Hampshire shows that those characteristics by which the species was recognized and defined are not merely those of a local variant in the Boston area. The occurrence of *arnoldi* in many other states, as well as in Canada, may be anticipated.

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BREVIORA

Museum of Comparative Zoology

CAMBRIDGE, MASS. MARCH 20, 1953 NUMBER 11

CHARACTERS AND SYNONYMIES AMONG THE GENERA OF ANTS

Part I

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Work now under way is aimed at a revision of the basic classification of the Formicidae down to generic and subgeneric levels. The present classifications are considered both unnatural and impractical, concealing as they do large numbers of generic and specific synonyms. I propose to differentiate genera only on the basis of discontinuities of a largely morphological kind, and it is hoped that by this method a useful and accurate key to the genera will become possible. Synonymies given here require discussion that is best set forth separately, so as not to clutter more nearly final, synoptic classifications and keys now being prepared.

MYRMECIA Fabricius

Myrmecia Fabricius, 1804, Syst. Piez.: 423. Genotype: *Myrmecia gulosa* Fabricius, by designation of Emery, 1911.

Myrmeciâ (*Promyrmecia*) Emery, 1911, Gen. Ins., Fasc. 118: 18–19. Subgenotype: *Myrmecia aberrans* Forel, by original designation. NEW SYNONYMY.

Myrmecia Clark, 1952, Formic. Australia, Melbourne, **1**: 21.

Promyrmecia Clark, 1952, *Ibid.*, p. 119.

The references of Clark should be consulted for further synonymy. Clark has stoutly defended the separation of *Myrmecia* and *Promyrmecia* as distinct genera, first on the basis of ability or inability to jump of the species concerned, and later, when saltation proved to have numerous exceptions in both directions, on morphological grounds.

Years of study of the myrmeciines by this author have produced in the 1952 reference (p. 20) a couplet summarizing the characters supposed to separate *Myrmecia* and *Promyrmecia*. The three characters contrasted are: (1) fraction of length by which the antennal scape surpasses the occipital border, (2) distinctness of metanotum, and (3) size, as mirrored in total length. In the first character, it may be observed from the descriptions of species of *Myrmecia* given by Clark himself in the pages following the couplet, that no less than one-third of the 59 forms recognized disagree with the couplet, and disagree in the direction of *Promyrmecia*. In at least some cases, the scape proportions are exactly as stated in the couplet for the upper limit of *Promyrmecia*. The distinctness of the metanotum is subject to varying interpretation, but from any reasonable point of view, the generality of the indistinctness of the metanotum in *Promyrmecia* cannot be defended. In fact, Clark's figures (*op. cit.*) in rapid survey are the best contradiction of his couplet that I can offer anyone without a large representation of material at hand for direct study. The "size" figures, even as cited in the couplet, are broadly overlapping and useless for the purpose to which they are put. Study of a good representative series of the species is convincing proof for me that size, as based on any measurable dimension or proportion of the worker or female so far utilized, is graded from the largest *Myrmecia* to the smallest *Promyrmecia* without a break.

It is entirely possible that study of the male genitalia, when a sufficient number of males becomes available, will demonstrate a set of cleavages that along with other characters will serve as discontinuities for the proper splitting of *Myrmecia*. Clark's and other divisions are here rejected for lack of evidence. It should be pointed out, in order to save possible future confusion, that Clark has synonymized *Halmamyrmecia* Wheeler with *Promyrmecia*, although he wrongly maintains *Myrmecia nigrocincta* Fr. Smith, its type, in the genus *Myrmecia* as he has defined it.

Rhytidoponera Mayr

Ectatomma (*Rhytidoponera*) Mayr, 1862, Verh. zool.-bot. Ges. Wien **12:** 731. Genotype: *Ponera araneoides* Le Guillou, by designation of Emery, 1911.

Rhytidoponera (*Chalcoponera*) Emery, 1897, Ann. Mus. Stor. Nat. Genova **38:** 548. [Sub] genotype: *Ponera metallica* Fr. Smith, by designation of Emery, 1911. NEW SYNONYMY.

Rhytidoponera and *Chalcoponera* treated as distinct genera, Wheeler, 1922,

Bull. Amer. Mus. Nat. Hist. **45**: 643–644. Clark, 1936, Mem. Nat. Mus., Melbourne, **9**: 14–15.

The large genus *Rhytidoponera* in the present broad sense includes species of typical ectatommine characteristics, distinguished in having the inferior pronotal margins just in front of the fore coxae armed on each side with an acute tooth; the hind coxae are completely unarmed above. Distribution is primarily Australian and Papuasian, with outliers in the "Wallacia" region and in the southern Philippines to the west, and in New Caledonia in the east.

The separation of *Rhytidoponera* from *Chalcoponera*, either generic or subgeneric, has been accepted from the time of Emery's first division of the few species then known. Rapid accretion of species in both groups has frequently led to puzzlement of authors trying to place new species in one group or the other, and this puzzlement has resulted in several published expressions of doubt accompanying specific descriptions.

The separation has been based on (a) proportions of certain antennal segments in worker and male, (b) development and pectination of the spurs of the middle and hind tibiae in the worker, (c) development of notaulices in the male, and (d) presence or absence of a normal winged female caste (Wheeler, *loc. cit.* 1922). If one applies these Emery-Wheeler key characters rigorously to a wide variety of species in *Rhytidoponera* and *Chalcoponera*, discrepancies are not long in appearing.

The tibial spurs of the middle pair of legs are reduced and narrow (rarely absent) in all species of both genera examined for this work, and may be safely disregarded. The extremes of development of breadth and pectination of the posterior spurs are largely in accord with the conventional separation of the two groups, but exceptions are glaring, and gradual transition from one type to the other is evident among a restricted selection of eastern Australian species. In the species *tenuis* Forel, which has *Chalcoponera* antennal funiculi and which has been placed in *Chalcoponera* by all authors, the posterior tibial spurs are minute and show the strongly reduced pectination supposed to be characteristic of *Rhytidoponera s. str.* Conversely, certain *Rhytidoponera s. str.* species, such as *R. malandensis* Forel, have the posterior spurs large, broad, and strongly pectinate; in fact, *R. malandensis* has the spurs considerably more broadly pectinate than in any *Chalcoponera* species I have seen, including the genotype.

In the worker funiculi, the proportions of the "critical" segments

are intergradient and fully ambiguous in a number of species, among them *R. reticulata* Forel, *C. lamellinodis* Santschi (paratypes), *C. dubia* Crawley, and all the species of the *C. impressa* Mayr complex. More ambiguous examples or outright contradictory species could be cited, but the above cases should serve to prove the point so far as the worker is concerned.

Concerning the male characters, a case similar to that for the workers can be drawn, but it will serve merely to focus on the New Caledonian fauna, consisting of a handful of forms in which the workers have been placed in *Chalcoponera* on the usual characters. The males of these species are, unfortunately for the generic division, endowed with the characters of *Rhytidoponera s. str.* Emery (1914, in Sarasin and Roux: Nova Caledonia, Zool. 1: 397) covers this situation adequately when he states: "The males of the New Caledonian species of *Chalcoponera* (*Rhytid. fulgens*, *numcensis*, *atropurpurea* and *acupuncta*) make an exception to the character that I have attributed to the subgenus concerning the structure of the antennae (Genera Insectorum, fasc. 118, p. 39). For the present, I am incapable of distinguishing the males of the two subgenera of *Rhytidoponera*." Apparently Wheeler overlooked this paragraph when he raised *Chalcoponera* to generic rank in 1922, citing in his key the same discredited male characters. I have dissected the male genitalia of several species representing *Chalcoponera* and *Rhytidoponera s. str.*, and the preparations fail to show differences except minor ones among the various species, without regard to the old division. The volsellae are uniformly much like those of *Myrmica* and the Dacetini in the subfamily Myrmicinae, and the other parts are on the usual formicid pattern.

It seems fairly obvious that most describers have pretty consistently ignored the formal characters in assigning new species to one group or the other; rather, assignment seems to have been made chiefly on the basis of size and habitus. On such a basis, I can make out not two, but several, species-groups of fairly distinctive relationships, but broadly intergradient one to the next. Of these, the *impressa* complex seems to have a combination of characters approaching nearest the hypothetical generalized *Rhytidoponera*. Disregarding certain aberrant species and complexes, such as the *turneri* group and the New Caledonian stock, the development of the majority of species seems to have followed two lines: one toward large species of the type of *mayri* Emery, *arancoides* Le Guillou, and *punctata* Fr. Smith, and one toward the type of *metallica* Fr. Smith and *victoriae* André. In the farflung

regions penetrated by *Rhytidoponera s. lat.* on the Australian continent, these two broad adaptive types have met with relative success, while the more generalized connecting types have been restricted to favorable forested areas, largely in the mountains of eastern Australia. Thus, while the *Rhytidoponera* species inhabiting the deserts, scrubs, heaths and eucalypt woodlands of the great, arid, open regions of Australia may seem to be amenable to assortment into two distinct groups, it must be borne in mind that the more generalized forest-loving species, while less familiar to the observer, form an effective bridge joining these two groups.

Before leaving *Rhytidoponera*, a word is required on the females. It has been assumed that *Chalcoponera* species always produce normal winged females, and that *Rhytidoponera s. str.* species do not. In 1950, Clark (*in litt.*) indicated to me that he had found females of some sort, presumably differentiable from the workers, in the latter group. To date, he has published nothing concerning this find, so that it is fitting that the old assumption be continued until definite information appears in print. My own field investigations in Australia (1950–51) indicate that the *R. impressa* group (*impressa, chalybaea, splendida*) normally produces a regular yearly crop of males and females in most mature nests during the first part of the dry season in each of the regions inhabited. Both sexes are winged before the nuptial flight, and fertilization and nest-founding are presumed to follow conditions more or less normal among the Ponerinae, as isolated females have been found dealated and inhabiting small cells in various situations in normal habitats. Outside the season for production of winged forms, only dealate females have been found in established nests in addition to the workers and such brood as occurs. When winged forms are found in a nest, these are always of both sexes so far as my observations go.

In species of the *metallica* group, a situation of a quite different sort is apparent. Among the common and widespread members of this group, such as *metallica, tasmaniensis*, and their very close allies, winged or obviously dealate females are very rare or unknown. The *victoriae* group is similar in this respect, although I have found a dealate female in a mature nest of the species common at Kuranda, in North Queensland, and have also found a lone winged female of *victoriae* floundering in the damp sand at the surf edge at Seaford, on Port Phillip Bay, in Victoria. Of several thousand nests of *victoriae, metallica, tasmaniensis* and very close allies of these species that I have opened, not one (with the single noted exception above) has yielded

a female of the normal type, either alate or dealate. Yet there are a few isolated specimens of normal females in these groups in the Museum of Comparative Zoology collection, most of which seem to have been taken singly on the wing or otherwise.

While it is conceivable that the rarity of females in the nests of such species may reflect the methods of investigation, and not true absence of this caste, another circumstance makes this seem unlikely. I refer to the very widespread occurrence of winged males in nests of the same species at all seasons of the year, a phenomenon that stands out among my Australian observations even though I failed to take quantitative notes that would have made it much more convincing. These males are usually present in small numbers, and may be found in the upper as well as the lower chambers of a given nest. They are very active, and either run to hide quickly or else take to ready flight. A more limited number of observations on the large deserticolous members of *Rhytidoponera s. str.* indicates that males are to be found in their nests on a somewhat similar basis, though observations through several seasons will be needed to confirm this.

Among some other, more rare and distributionally restricted species, *R. crocsus* Emery appears to have normal females most or all of the time, while *R. aspera* (Roger) is recorded as having this caste at least some of the time. For most of the species of the "inter-subgeneric" and aberrant groups, workers only are known at present, but these forms are so rare and so little-investigated that presence or absence of winged females cannot be assumed on any reasonable grounds. Under the circumstances as outlined, utilization of the presence or absence of a true female caste as a taxonomic character would seem entirely premature.

The situation in the female-less or female-rare species that have been fairly extensively investigated is, however, of considerable interest apart from taxonomic considerations. In two such species, I have seen a male seeking to enter an alien nest, apparently of the same form. In the spring, in southeastern Australia and the dry Northern Flinders Ranges of South Australia, at least, males of these forms are often seen hawking in rapid flight low over the ground in the manner of certain mutillid and thynnine males during the sexual search. Observations in 1951:

On the 12th of September, in a strip of open eucalypt woodland at Burwood, near Melbourne, Victoria, I noticed such a male in flight on a cool, sunny afternoon. While following him, I suddenly saw him

alight and disappear without hesitation into a small hole in the ground. This hole, when attacked with a trowel, proved to be the entrance to a nest of *R. tasmaniensis*, a nest containing, so far as I could dig on this occasion, workers and two males, the latter indistinguishable from males taken in nests of this species on other occasions. One of these males, found just below the entrance, must have been the male I saw entering just before I started to dig.

At Wilpena Pound, a sort of natural oasis in the arid Flinders Ranges of South Australia, the evening of November 25 brought an abundant flight of a large brown *Rhytidoponera* species, entirely males, to our camp pressure lanterns. Later that night, some rain fell and there were electrical storms on the adjacent peaks. On the next day, in an area of *Triodia* grass within the Pound, I found a low, gravel-studded mound with wide, slit-like entrance, of the type made by certain arid-land species of *Rhytidoponera* and *Camponotus*. The nest was seen in the path taken on the way out, and was not excavated until returning toward camp, late in the afternoon when the sun had fallen very low. While I was bending over to deal the hard clay mound a first blow, a large male of *Rhytidoponera* came, flying in low over the ground from a distance, and landed directly on the lip of the entrance slit, which it immediately entered. This was surprising, as no sign of life had been detected around the mound at either time of inspection (the species concerned, probably *R. mayri* Emery, is, with its close relatives, a primarily crepuscular and nocturnal forager). The nest was immediately attacked, and the male recovered quickly several inches down along the main entrance passage. Further digging secured only a few workers of *R. mayri* Emery.[1]

While these two incidents, observed by chance, are scarcely to be considered definite proof of an established behavior pattern, the observations made to date on various *Rhytidoponera* species suggest the following hypothesis, now being tested by Haskins (*in litt.*).

Rhytidoponera (*s. lat.*) varies by species and species-groups in presence, absence or rarity of a normal female caste, and varies correspondingly in behavior of and toward the males. In the species in which normal females are rare or absent, it may be assumed that deposition of fertile eggs is wholly or largely taken over by workers

[1] The species described by Clark as *R. stridulator* and *R. dixoni*, along with some other forms are supposedly distinguished from *R. mayri* by details of petiolar structure and body sculpture. Single nests of what I take to be *mayri*, however, show a wide range of variation in these same characters, and Clark has not made the differences sufficiently clear to convince me that his species are really distinct.

or highly modified ergatoids. It is possible that apparatus for the retention of sperm is strongly impaired in such hypothetical individuals; if so, then the need for constant refertilization would seem to call for the constant presence of consort males in the nest. Meager observations seem to indicate that males sometimes, perhaps normally, leave the parent nest and enter another nest of the same species, where they may remain as guests for long periods. If observation and controlled experiment corroborates the above hypothesis, a new and extremely interesting kind of behavior will be added to the multiplicity of patterns known among the ants, and the origin of certain similar male habits among the Dorylinae may be easier to understand.

Centromyrmex Mayr

Centromyrmex Mayr, 1866, Verh. Zool.-bot. Ges. Wien **16**: 894. Genotype: *Centromyrmex bohemani* Mayr, monobasic.

Typhloteras Karawajew, 1925, Konowia **4**: 128. Genotype: *Typhloteras hamulatum* Karawajew, monobasic. NEW SYNONYMY.

Karawajew based his genus on a specimen with only a single, large pectinate spur on the posterior tibiae, and thereby carried it out to Emery's Group III of the tribe Ponerini. This placement is only another example of the great faith formerly held by many authors in the constancy and taxonomic importance of the number and condition of the spurs of the middle and hind tibiae. In fact, the character in question is a very poor one upon which to base a classification, especially in the Ponerini. If one reviews the situation in various *Centromyrmex* species, including *Centromyrmex hamulatus* NEW COMBINATION, it is at once apparent that the number and condition of the spurs in question differ by species, and possibly even within species. Thus, either the middle, or the posterior, or even both pairs of tibiae may possess the extra lateral spur in a more or less rudimentary condition, while the degree of development of the medial spurs and their pectination is also variable from one species to the next.

In other characters, including the striking general habitus and the probably general termite-eating proclivities, the species here included in *Centromyrmex* form a very homogeneous and natural-seeming group. To break up this combination on the basis of spur characters, one must, as did Karawajew, go to extraordinary lengths in invoking "convergence" as a possible explanation of the common resemblances; to be thorough in applying the same logic, one would have to distribute the few species involved among three or four genera. In any case, the

tibial apices of several of the species bear such a dense growth of heavy, spine-like setae that the identification of a spur rudiment of similar size becomes an academic exercise. In addition to the synonymy of *Typhloteras* with *Centromyrmex*, it becomes necessary to point out that the subtribe Centromyrmicini of Emery is a NEW SYNONYM of tribe Ponerini if the spur characters will not hold.

Pristomyrmex Mayr

Pristomyrmex Mayr, 1866, Verh. Zool.-bot. Ges. Wien **16:** 903. Genotype: *Pristomyrmex pungens* Mayr, monobasic.

Odontomyrmex André, 1905, Rev. Ent. Caen **24:** 207.

Hylidris Weber, 1941, Ann. Ent. Soc. Amer. **34:** 184, 190. Genotype: *Hylidris myersi* Weber, monobasic. NEW SYNONYMY.

Hylidris defended, Weber, 1952, Amer. Mus. Novit. **1584:** 15–22.

When, in 1941, Weber first described *Hylidris*, he did so without realizing that it might be closely related to another genus like *Pristomyrmex*. By 1952, he has realized this relationship and is at some pains to mark out its boundaries. His new approach to the situation lies in segregating the African species of *Pristomyrmex* from the Indo-Australian ones; the former group, rallied about *H. myersi* as genotype, is given the name *Hylidris*. He is vague about what genus the Indo-Australian species are to belong to, but these are presumably to remain in *Pristomyrmex*. The characters of *Hylidris* are cited briefly, but are not contrasted with those of *Pristomyrmex s. str.* in any direct statement. Instead, Weber gives briefly his views on generic limits, which he feels should be arbitrarily drawn in some cases. (For my contrasting opinion, see the introduction to this paper.)

Summing up, it may be said that Weber's division of *Pristomyrmex* is based upon characterization of only one of the resultant groups, and no assurance is given that the characters are exclusive to that group. In point of fact, these characters are *not* exclusive to the African group. Since Weber claims to have examined the Indo-Australian species, at least in part, it may be wondered that he did not note this fact for himself; perhaps he did note it, and offered the generic-limit discussion as a defense against protests he felt would be lodged against *Hylidris*.

I cannot follow Weber's generic split, which I regard as wholly arbitrary. Significantly, Weber fails to mention the old synonym *Odontomyrmex*, a name put forward by André for a species that appears to have the chief definitive characters of *Hylidris*. Mann (1919, Bull. Mus. Comp. Zool. **63**: 341) delivered the coup de grâce to *Odonto-*

myrmex when he noted two specimens of his *Pristomyrmex obesus melanoticus* having a prominent tooth on one side of the pronotum, but none on the other side. We do not need to appeal to abnormal specimens in this case, however, as the known, normal specimens of the Indo-Australian and African regions form a tightly intergradient series with respect to the development of the posterior propodeal and anterior alitruncal pairs of teeth and the smooth to foveate-reticulate sculpture. This series, in my opinion, does not even split into respectable species-groups on the basis of the known characters, let alone genera or subgenera. Series of several undescribed species in the Museum of Comparative Zoology and J. W. Chapman collections serve only to fortify this opinion.

GAUROMYRMEX Menozzi

Gauromyrmex Menozzi, 1933, Natuurhist. Maandblad **22:** 146. Genotype: *Gauromyrmex bengkalisi* Menozzi, monobasic.

Solenomyrma Karawajew, 1935, Treubia **15:** 103. Genotype: *Solenomyrma acanthina* Karawajew, monobasic. NEW SYNONYMY.

Acalama M. R. Smith, 1948, Jour. N. Y. Ent. Soc. **56:** 205–207. Genotype: *Acalama donisthorpei* M. R. Smith, monobasic. NEW SYNONYMY.

This genus is very doubtfully distinct from *Vollenhovia* Mayr, from which it may at present be distinguished by means of the 11-segmented antennae and the bidentate propodeum, *vs.* 12-segmented antennae and unarmed propodeum in *Vollenhovia*. The characters are very weak ones, and may be compromised in species in this complex that are presently not available to me. *Vollenhovia emeryi* Wheeler, with 12-segmented antennae, has minute propodeal teeth, and the median funicular segments are so reduced in length as to be virtually obsolete; the step to *Gauromyrmex* from this species is a very short one. The amber species *Vollenhovia beyrichi* (Mayr), if properly placed by Wheeler, would be intermediate in the critical characters.

Types of *Gauromyrmex bengkalisi* and *Acalama donisthorpei* were examined, and are considered specifically distinct, but not generically so. Specific synonymy is formalized as follows:

GAUROMYRMEX ACANTHINUS (Karawajew) new combination

Solenomyrma acanthina Karawajew, 1935, Treubia **15:** 103–104, fig. 23, worker.

Acalama donisthorpei M. R. Smith, 1948, Journ. N. Y. Ent. Soc. **56:** 207–208, figs. 1, 2, worker. NEW SYNONYMY.

Types of Smith's species and *Gauromyrmex bengkalisi* have been examined through the kindness of Dr. Smith. The former species has

been compared with Karawajew's description and figure, and also with the West Chinese series taken by myself, and mentioned by Smith (*loc. cit.*, p. 206). The comparison gives the distinct impression that one is dealing with a single variable species. Variation is chiefly in size (slight), distinctness and acuteness of propodeal teeth, and depth of pigmentation, but the present evidence does not warrant subspecific distinction in my opinion. This ant appears to be rather common in India and China, and I believe that I have seen it on several occasions in Bengal Province nesting under loose bark, though the actual specimens were lost in a wartime shipment. In life, the distinctive point of recognition lies in the extremely depressed appearance of the ant, even when moving about. It appears to the naked eye somewhat like a flattened *Leptothorax*, and its attachment to tree trunks and plant cavities may be correlated with the habitus.

At the time of Dr. Smith's investigation of this insect, he sent specimens to me, and I failed to recognize it as any described species. The published descriptions of Menozzi and Karawajew came to light later. The entire case of these synonymous genera should prove my frequently-held point that the classification of the Myrmicinae is long overdue for complete revision.

Tribe AMBLYOPONINI

Onychomyrmicini Ashmead, 1905, Canad. Ent. **37:** 382.
Examblyoponini Donisthorpe, 1949, Ann. Mag. Nat. Hist. (11) **15:** 401.
Reneini Donisthorpe, 1947, Ann. Mag. Nat. Hist. (11) **14:** 183. NEW SYNONYMY.

Prionopelta Mayr

Prionopelta Mayr, 1866, Sitzb. Akad. Wiss. Wien **53:** 503. Genotype: *Prionopelta punctulata* Mayr, monobasic.
Ponera Fr. Smith (*partim*), 1860, Journ. Proc. Linn. Soc. London, Zool. **4** (suppl.): 105, *nec* Latreille.
Examblyopone Donisthorpe, 1949, Ann. Mag. Nat. Hist. (11) **15:** 401. Genotype: *Examblyopone churchilli* Donisthorpe, monobasic: *vide infra.*
Renea Donisthorpe, 1947, Ann. Mag. Nat. Hist. (11) **14:** 183. Genotype: *Renea testacea* Donisthorpe, monobasic. (*Nec Renea* Nevill, 1880, in Mollusca.) NEW SYNONYMY. *Vide infra.*

Incredible as it may seem, Donisthorpe based his two new genera and two new tribes on two new species, both of which are synonymous with *Prionopelta majuscula* Emery. The same author had already proposed a new name for a synonym of the same species, so he has

achieved the unequalled feat of proposing for the same species three new specific, two new generic and two new tribal names. The synonymy of *Prionopelta majuscula* follows:

PRIONOPELTA MAJUSCULA Emery

Ponera simillima Fr. Smith, 1860, Journ. Proc. Linn. Soc. London, Zool. **4** (suppl.): 105, "worker," ♀, *nec* Fr. Smith, 1860, *op. cit.*, p. 104. NEW SYNONYMY.

?*Rhopalopone simillima*, Emery, 1900, Term. Füzetek **23:** 311. 1911, Gen. Ins. **118:** 35.

Prionopelta majuscula Emery, 1897, Term. Füzetek **20:** 595–596, worker, ♀. Brown, 1951, Bull. Brooklyn Ent. Soc. **46:** 102, *Examblyopone churchilli* synonymized.

Prionopelta poultoni Donisthorpe, 1932, Ann. Mag. Nat. Hist. (10) **10:** 462, *nom. pro Ponera simillima* Fr. Smith, II. NEW SYNONYMY.

Examblyopone churchilli Donisthorpe, 1949, Ann. Mag. Nat. Hist. (11) **15:** 401–402, ♀.

Renea testacea Donisthorpe, 1947, Ann. Mag. Nat. Hist. (11) **14:** 183–186, fig., worker, ♂; pp. 590–591, ♀. NEW SYNONYMY.

In his original description of *Ponera simillima* II, Frederick Smith describes a "worker" and also gives characters purporting to be those of a winged female. In his treatment of 1932, Donisthorpe mentions as Smith's type "1 dealated ♀" from "Dor." [Dory, A. R. Wallace]. It is by now fairly well known that some of the Dory insect material, at least among the coleopterous collections in the British Museum, is suspected to be from other East Indian localities. Smith's description fits *Prionopelta majuscula* better than it does either of the other two *Prionopelta* species known from the Indo-Papuasian area (*P. kraepelini* Forel and *P. opaca* Emery), so there is no reason to question this particular record for a widespread New Guinea species. The assumption must be made, of course, that Donisthorpe's 1932 assignment to *Prionopelta* was correct; there is every reason to believe that it was so.

In 1951, I determined that a paratype female of *Examblyopone churchilli* was synonymous with *P. majuscula* and returned the type to Dr. E. S. Ross at the California Academy of Sciences. Dr. Ross was the original collector (at Maffin Bay, Dutch New Guinea) of both *E. churchilli* and *Renea testacea*, and he has recently sent me workers and males from the type series of the latter species. The workers fit Emery's diagnosis of *P. majuscula* very neatly, except for the usual small size difference resulting from Emery's habitual under-

measurement. This being the case, I asked Dr. Ross to compare the female specimens assigned by Donisthorpe to *R. testacea* with the female holotype (defective) of *E. churchilli*. He has replied (*in litt.*) that the correspondence of form, etc. is as good as can be expected, allowing for the missing parts of the *E. churchilli* type. The *R. testacea* workers differ as expected from authentic workers of *Prionopelta opaca* and *P. kraepelini* in the Museum of Comparative Zoology and match the differences from *P. opaca* listed by Emery in the original description of *P. majuscula*.

P. majuscula is larger than the other two Indo-Papuasian species, and its worker has the dorsum of the head and alitrunk very definitely shining, with minute, spaced punctulation. The female is considerably larger and darker than the worker, and has stronger punctulation; the head is darker than the rest of the body. Both *P. kraepelini* and *P. opaca* are not only smaller, but also there is only a slight difference between the worker and female stature in these species; the dorsum of the head is densely and more coarsely punctulate and opaque, especially in *opaca*. The worker and female of *kraepelini* and the worker of *majuscula* are pale to bright yellow in color, while the females of *majuscula* and *opaca* and the worker of *opaca* are darker, ranging from ferrugineous brown to blackish-brown. *P. opaca* and *P. majuscula* appear to be widespread on New Guinea and neighboring islands, while *P. kraepelini* is a more westerly, Indomalayan species that has spread into the Pacific as a tramp and has reached the Philippines in the north at Dumaguete, Negros Oriental: several series (J. W. Chapman and D. Empeso).

BREVIORA

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A CAVE FAUNULE FROM WESTERN PUERTO RICO WITH A DISCUSSION OF THE GENUS *ISOLOBODON*

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In spite of the diligent work of H. E. Anthony nearly 40 years ago, the vertebrate paleontology of Puerto Rico must still be described as incompletely known. Anthony's labors have not been followed up in any systematic fashion by other investigators, and much therefore remains to be done.

The present paper places on record a collection from an area of the island relatively neglected by Anthony — the extreme western portion of Puerto Rico. The collection, though small and apparently representing a fauna of no high antiquity, permits new locality records for certain forms and includes a very interesting specimen of the genus *Isolobodon* which has compelled us to inquire into the variability of that genus and into the propriety of taxonomic subdivisions of it.

The materials here recorded were obtained by the senior author during the fall and winter of 1948–49 at the mouth of the Cueva Monte Grande between Mayagüez and Cabo Rojo (Distrito de Mayagüez, Pueblo de San German, Barrio de Monte Grande). The specimens have been deposited in the Museum of Comparative Zoology.

There were several levels in the deposit, and part of the deposit was kitchen midden, but no record was kept of the level at which specific material was found.

We cite below only the mammalian component of the faunule. There are, however, also fish, bird, turtle, snake and lizard bones. The lizard jaws have been identified by Rodolfo Ruibal and Max K. Hecht as all belonging to *Anolis cuvieri*, the living giant anole of Puerto Rico. No attempt was made to identify limb bones in any group. In the case of the mammals we take this opportunity to cite also localities not previously published but represented in the collections of the Museum of Comparative Zoology (MCZ) or the American Museum of Natural History (AMNH).

The Monte Grande Faunule

INSECTIVORA

Nesophontes edithae

Two mandibular halves.

This large extinct insectivore of Puerto Rico has previously been reported from Hacienda Jobo, Morovis and Utuado. The MCZ collections show it also from Ciales, Manati and Rio Piedras.

CHIROPTERA

Noctilio leporinus mastivus

One complete skull. Two mandibles.

Though recorded by Anthony (1926) only from Old Loiza, this form was collected by Anthony and Goodwin at Vega Baja (AMNH specimen) during a 1926 West Indian expedition which has never been fully reported in the literature. The present is therefore the third record for this large fish-eating bat in Puerto Rico.

Chilonycteris parnellii portoricensis

One skull.

The specimen so referred seems somewhat small for the species, but it is much too large to be the small Puerto Rican species of the genus (*C. fuliginosa inflata*). It is probably a young specimen.

This subspecies seems to be relatively rare in collections, only 11 specimens having been previously obtained, representing four localities: Cayey, Morovis, Pueblo Viejo and Trujillo Alto.

Monophyllus portoricensis

One skull.

This species was recorded by Anthony (1926) from five localities: Bayamon, Cayey, Morovis, Pueblo Viejo and Trujillo Alto.

Brachyphylla cavernarum

Four more or less complete rostra. Six complete mandibles. Seven half-mandibles.

Recorded by Anthony from six localities: Cayey, Comerio, Corozal, Morovis, Pueblo Viejo and Trujillo Alto.

Artibeus jamaicensis jamaicensis

One skull. Six mandibles.

This very common form was obtained or reported by Anthony from 14 localities.

Eptesicus fuscus wetmorei

One mandible.

Anthony (1926) reported this species from four localities (Maricao, Morovis, Pueblo Viejo and San German). He had collected it also at Trujillo Alto (AMNH specimen) during the 1916 expedition but somehow overlooked this record in his publication.

RODENTIA

Rattus sp.

Two mandibles. One half-skull.

Rattus, as always in the Western Hemisphere, indicates that at least part of the Monte Grande faunule was post-Columbian in age.

Elasmodontomys obliquus

A fragment of an upper incisor and a third right upper molar appear to represent this species.

This large extinct rodent has previously been reported only from Ciales, Morovis and Utuado. The MCZ collections add it also from Rio Piedras.

Isolobodon portoricensis

Nineteen skull fragments. Fifty-five half- or partial mandibles.

The bulk of the material from Cueva Monte Grande is of a medium sized hypsodont rodent. The enamel folds of the molars are nowhere completely separated to form laminae. The lateral surfaces of these

teeth have the pattern of striations characteristic of the genera or subgenera *Isolobodon* and *Aphactreus*. Even a cursory inspection of the molar pattern, however, rules out *Aphactreus* (Miller 1929a, pl. 2). The specimens then seem referable to *Isolobodon*. The only species of that genus which has previously been recognized on Puerto Rico is *Isolobodon portoricensis*, and almost all of the specimens agree well with this form in both size and pattern and may immediately be placed as representatives of this species.

Specimens of *Isolobodon portoricensis* from Monte Grande afford a new record of locality but less clearly than the other forms recorded above, since Anthony has already reported this species from nearby Cabo Rojo as well as from Ciales, Manati, Salina, San German and Utuado. (The MCZ adds Saliche and Aguirri.)

Four of the Monte Grande mandibles, however, are not immediately classifiable as *I. portoricensis* and require special attention. All are much smaller in size than fully adult *I. portoricensis*. Two are obviously immature. One of these is edentulous; the other has completely unworn crowns to the teeth, which are, therefore, not readily compared with the worn adult molar pattern. However, by breaking the ventral surface of the mandible, it has been possible to discover from underneath the pattern of the enamel ridges which will be eventually revealed by growth. The enamel pattern so revealed is exactly that of typical *I. portoricensis*.

The third small mandible is larger than the other two and although considerably smaller than adult *I. portoricensis* shows no morphological evidences of immaturity (last molar not fully erupted, unworn molar pattern, absence of bony shelf behind the last molar). The fourth mandible is similar to the third in size but is edentulous.

Subadult mandibles equivalent in size to these last two Monte Grande specimens are known from many localities elsewhere in Puerto Rico and in Mona and the Virgin Islands and are always indistinguishable from the adults except in size. It is, therefore, clear that small size is in itself no bar to considering the four questionable Monte Grande mandibles as *I. portoricensis*, and we refer the two obviously immature specimens to that species without further discussion. The fourth mandible, lacking teeth, manifests no distinctive characters and may tentatively be referred to the same species.

The third questionable specimen differs, however, in molar pattern from all the numerous specimens of *Isolobodon* with which it has been

compared. In any *Isolobodon* three important enamel folds are evident, a single main fold from the labial side and two counterfolds from the lingual side. In the Monte Grande specimen in question the anterior counterfold of the first molar shows a distinct constriction about midway along its length and, correlated with this, there is a marked broadening of the lingual lobe anterior to the counterfold. No similar constriction is present on the second and third molars; the anteriormost lingual fold may have been broadened on both these teeth, but fractures in the critical regions make it impossible to confirm this. No constriction comparable to that on the first molar, nor any broadening of the anterior lingual lobe at all similar to that seen on the first molar and probable on the second and third molars of the Monte Grande specimen, have been found in the more than 250 *Isolobodon portoricensis* mandibles examined. This third, small, Monte Grande mandible may, therefore, represent an exceedingly rare species, possibly reaching a smaller adult size, but closely related to *Isolobodon portoricensis*. On the other hand, it may represent a rare mutant condition in a subadult individual of *I. portoricensis*. Of these two alternatives we consider the second the more economical hypothesis, since we have been unable to find any other consistent differences between the third, small, Monte Grande mandible and the mass of compared *I. portoricensis*. We feel that the counterfold constriction might have been caused by a single mutant gene. It is interesting that this apparently aberrant individual probably never reached full adulthood.

In the course of this investigation, and while small size as a possible species character was still in question, the Monte Grande mandible and other *Isolobodon* material from Puerto Rico was carefully compared with material identified as *Isolobodon levir* from Hispaniola. It is worthwhile to consider here the status of the latter species, but before doing so a brief resume of its taxonomic history seems in order.

I. levir was first described by Miller (1922) as a distinct genus and species, *Ithyodontia levir*, from two molars found fossil at St. Michel. He did this believing that these isolated teeth were lower molars. Twelve mandibles from the same locality were identified as *Isolobodon portoricensis* without comment. In 1929, after studying much more material from the same locality, he realized that the two molars of "*Ithyodontia*" were actually upper molars of *Isolobodon*. In an attempt to save *I. levir* from complete synonymy, he noted that all St. Michel specimens were smaller than *Isolobodon* from other Hispaniolan

(kitchen midden) localities. The latter, in turn, were indistinguishable from Puerto Rican *I. portoricensis*. Although he could find no morphological characters to distinguish them, he nevertheless separated the St. Michel specimens as a distinct species on size alone. He pointed out, however, that Hispaniolan *I. portoricensis* came from kitchen middens, whereas *I. levir* came from owl pellet deposits. As he indicated, smaller species and individuals are usually found more frequently in owl deposits than in kitchen middens, but he believed that the presence in St. Michel caves of relatively large mandibles of the related genus or subgenus *Aphaetreus* ruled out the suggestion that in the two types of Hispaniolan *Isolobodon* he was dealing with large- and small-sized samples from the same population. In later papers (Miller 1929b, 1930) he records *I. levir* from several other Hispaniolan localities (San Gabriel, Monte Cristi, Constanza, Trujin), in Monte Cristi actually in association with *I. portoricensis*.

After extensive comparisons of *I. portoricensis* from Puerto Rico and surrounding islands (AMNH material) with *I. levir* from Hispaniola (MCZ material from Fort Liberté as well as material from the United States National Museum, especially mandibles from St. Michel, Monte Cristi and Anadel, but also skulls from these and other localities), we agree with Miller that no morphological characters are to be found to separate the two species. We fail, however, to see any clearcut size difference, since the smaller species "*levir*" appears to us to grade into the larger species *portoricensis*. "*I. levir*" mandibles from Hispaniola can be matched by equally small mandibles from Puerto Rico. We believe also that in some cases Miller introduced a false dichotomy into his measurements by comparing the largest specimens identified as *I. levir* with the largest *I. portoricensis:* it is unlikely that a bimodal distribution would have resulted in the one case of actual association of the two forms if measurements of all measurable specimens had been used. For these reasons we consider *Ithyodontia levir* Miller a complete synonym of *Isolobodon portoricensis* J. A. Allen. *Isolobodon* thus emerges as a monotypic genus or subgenus, undifferentiated from Hispaniola through Mona and Puerto Rico to the Virgin Islands. As has already been pointed out (Miller, 1918) this wide uniform distribution may well have been brought about by human transport. If that be true just what was the original range of the genus before the coming of man to the Antilles. This would seem impossible to determine now.

Acknowledgments. We are indebted to the Departments of Mammals of the Museum of Comparative Zoology, the American Museum of Natural History, and the United States National Museum for the privilege of examining and comparing specimens.

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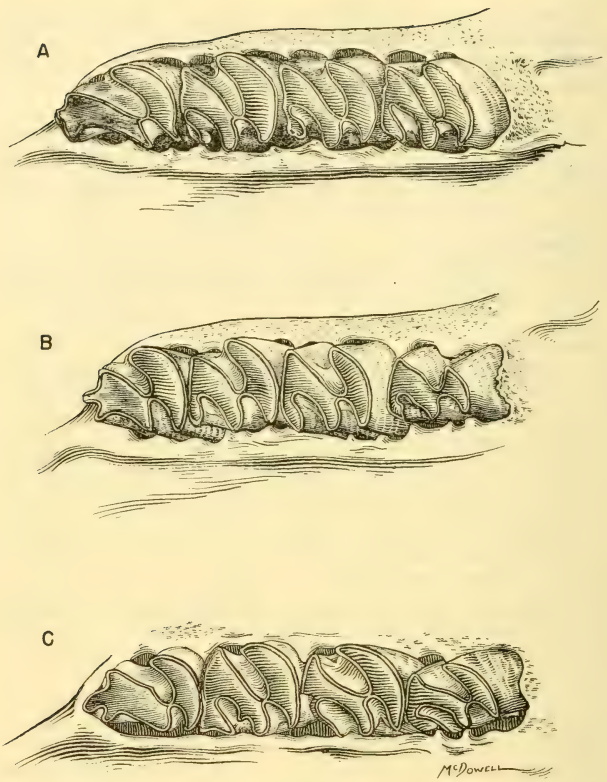

PLATE

Crown views of mandibles of *Isolobodon*. *A*. *"Isolobodon levir"*. U.S.N.M. No. 255874 from Monte Cristi, Dominican Republic. *B*. *Isolobodon portoricensis*. A.M.N.H. "0.1" Utuado, Puerto Rico. *C*. Aberrant Monte Grande mandible. M.C.Z. Cueva Monte Grande, Puerto Rico. (These specimens, all of about the same size, have been selected to show the extremes of variability of molar pattern.) 5 x natural size.

BREVIORA

Museum of Comparative Zoology

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FOSSILS AND THE DISTRIBUTION OF CHELYID TURTLES

1. *"Hydraspis" leithii* (Carter) in the Eocene of India is a Pelomedusid

BY ERNEST WILLIAMS

For 80 years a fossil turtle from the Eocene of India has been referred to the Recent South American chelyid genus *Hydraspis* (not of Bell 1828, correctly called *Phrynops* according to Stejneger 1909, and Lindholm, 1929). In spite of the zoogeographical interest of this record the evidence for this assignment has not previously been re-examined critically.

In view of the prevalent idea that the family reached Australia from Asia, the occurrence of a chelyid in the Eocene of India would be neither surprising nor unwelcome. Reference, however, of an Eocene Indian fossil to a modern South American genus is more suspect and obviously calls for re-investigation. Examination of the original description leads to a verdict unfavorable to both the generic and the family assignment.

The fossil in question was brought to scientific attention just over 100 years ago. In 1852 H. J. Carter in a study of the geology of the island of Bombay described as *Testudo leithii** the remains of a small turtle from the Intertrappean beds. Carter was not deceived as to the affinities of the form; he was using the generic name *Testudo* in a Linnaean sense and explicitly stated that he regarded his fossil as close to *"Sternothaerus"* (= *Pelusios*). He published two good plates giving a reconstruction of the fossil made from nine partial specimens. These

Testudo leithii Carter 1852 preoccupies *Testudo leithii* Günther 1869 for the tortoise of Egypt. The available and correct name of the latter then appears to be *Testudo kleinmanni* Lortet 1883

plates and his text description are the basis of all subsequent discussion. The type material cannot now be located in India and has never been restudied.

On the basis of the 1852 description, Gray in 1871 reassigned the Indian fossil. He remarked: "The description and figure of the carapace induce me to believe that the fossil is nearly allied to some of our existing South American species of the restricted genus *Hydraspis*; and the remains of the head, which are unfortunately imperfect, lead to the same conclusion. . . ." This determination has been very generally copied, in spite of the zoogeographical anomaly upon which Gray himself commented.

I find it necessary to disagree with Gray on the basis of the figured morphology of both shell and skull. Plates 1 and 2 are reproductions of Carter's plates X and XI with a few inessential modifications for clarity.

According to Carter's plate X (though the area is given in dotted lines only) and according to his express statement in the text there is no nuchal scute in the Indian fossil. Lydekker (1889b, p. 170) stated: "The omission of a nuchal shield in the restoration of the anterior border of the carapace is probably incorrect." Perhaps, however, Lydekker made this statement only on the ground that if the form were *Hydraspis* it should possess a nuchal scute. Absence of a nuchal scute would rule out all Recent genera of Chelyidae except *Chelodina* and *Emydura* (in both of which the scute may be present or absent) and *Elseya* (in which it is regularly absent). The latter genera are all natives of the Australian region.

In Carter's fossil the first vertebral is much smaller than the second vertebral. This precise condition is not met with in the living Chelyidae. In most Recent South American forms including most of the species of *Hydraspis* (= *Phrynops*) the first vertebral is on the contrary much larger than the second. There is, it is true, an approach to the condition of the fossil in the Australian genera *Emydura*, *Pseudemydura* and *Elseya* and in the South American *Hydraspis tuberosa* (specimens in the British Museum) and perhaps in some specimens of the South American genus *Hydromedusa*, but in the latter only if the anterior median scute is interpreted as a nuchal withdrawn from the margin rather than as a transversely divided first vertebral. In none of these, however, is the first vertebral as much smaller than the second as it is in the fossil.

In the Indian fossil the gulars are small, and the very broad inter-

gular extends from the anterior margin to the humero-pectoral sulcus, separating the humerals in the midline. This pattern of scutes on the anterior plastral lobe is different from any which is known in the modern Chelyidae. In all the genera except *Chelodina*, *Pseudemydura*, and rarely in *Emydura* (Siebenrock, 1907) the humerals meet in the midline for a significant distance behind the intergular. The intergular also is rarely as broad as in the fossil. In *Chelodina* the intergular is very large and separates the humerals, indeed extending deep into the area of the pectorals, and, except in *C. intergularis* Fry, it does not reach the anterior plastral margin, the gulars meeting in front of it. In *Pseudemydura* (Siebenrock, 1907) the intergular is like that of the Indian fossil in its breadth but as in *Chelodina* dips deeply between the pectorals. The gular-intergular pattern in the exceptional *Emydura subglobosa* in which Siebenrock found the intergular separating the humerals is also quite unlike that of the Indian fossil, the intergular being narrow and of quite different shape.

The feeble xiphiplastral notch is another feature in which the fossil differs from *Hydraspis* and other chelyids except the forms of the Australian region and *Batrachemys*.

The shell, therefore, is not a good match for that of any known genus of chelyid. It is perhaps most like those of the Australian genera but differs from all of these in significant details, for example, in the presence of neurals, which are lacking in all the Australian genera.

The skull and mandible in their turn provide conclusive evidence against chelyid affinities. The mandible, although incomplete, is stouter and broader than in any known chelyid. The symphysis must have been long, in strong contrast to the condition in chelyids. The skull, shown by Carter only in dorsal view, is radically different from that of any chelyid. The skull roof has undergone emargination from behind as in the Pelomedusidae or most Cryptodira. As a result, the parieto-squamosal arch is absent, but a jugal-quadratojugal bar is present. In the Chelyidae and in no other turtles the skull is emarginated from the ventral margin only, and a parieto-squamosal connection is (except in *Chelodina*) always preserved. In chelyids the quadratojugal and the bar of which it was a part are always absent. These are as crucial and clearcut differences as it is possible to obtain between skulls of turtles. Carter's fossil cannot be a chelyid.

It is most probable that it is a pelomedusid. Reference to this family would, it will be recalled, be a return to the opinion of the original describer, who thought the fossil was closest to the African

pelomedusid genus *Pelusios*. The characters of the shell fit such a reference extremely well. The nuchal scute is almost always absent in pelomedusids. The first vertebral is almost always smaller than the second (exception in *Palaeaspis* Gray, and sometimes in *Pelusios*). An intergular separating the humerals is found in *Stereogenys podocnemoides* and in *Elochelys perfecta* as well as in occasional individuals of *Podocnemis expansa*. The xiphiplastral notch is very variable in pelomedusids. Vertebral shields 2 to 4 of the Indian fossil have strikingly convex anterolateral borders, conspicuously concave posterolateral borders, as in some Recent *Podocnemis* and a number of fossil pelomedusids.

A final feature which, as described and figured by Carter, is anomalous, may be clinching proof of the pelomedusid affinity of this form. Gray mentioned that Carter's form was "peculiar also for the underside of the marginal opposite the (pectoral-humeral) suture being rather broader than the rest and angular on the inner edge, which I have not seen in any of the Recent species." If we have to do here with sulci between scutes, the situation is indeed peculiar and unique, but it is noteworthy that the lateral marginal scute boundaries are represented by dotted lines in Carter's original reconstruction (solid lines in plate 2 here) except for the anomalous "marginal" in question. It is noteworthy also that the ventral view of the lateral marginals in Carter's plates does not match the dorsal view of the same marginals. It is evident that Carter was not certain of the exact scute boundaries here, and it is possible that he has figured as the anomalous "marginal" the sutures between bones rather than the sulci between scutes. The lines drawn solidly by Carter in this region are in nearly the right position and have the right aspect to represent in their lateral portions the sutures bounding small mesoplastra and medially the hyo-hypoplastral suture. This interpretation is the more probable because Carter's figure is a reconstruction from nine specimens, one of which may have shown the sutures in this critical region and not the sulci. If small laterally placed mesoplastra were present, this fact would definitely place the Indian form in the Pelomedusinae of Zangerl (1948) with which, on the basis of other resemblances in its shell, it is most plausibly linked.

Carter's turtle is, therefore, most probably a new genus of pelomedusine. I cannot distinguish it from all previously proposed genera of pelomedusines because not all of these are themselves well-delimited. Thus I cannot distinguish it from *Rosasia* (Carrington da Costa 1940)

because at present that genus does not seem to be definable. (On its known characters *Rosasia* might be a synonym of any one of several genera. The carapacial shield, which alone is known, is not sufficiently diagnostic.) I cannot distinguish the Indian fossil from *Dacochelys* (Lydekker, 1889a) because there are no comparable parts, that genus having been founded on a mandibular symphysis, a part that is missing in Carter's fossil. There is also no evidence that *Dacochelys* is a pelomedusid.* I distinguish Carter's form, with some hesitation, from *Elochelys* Nopcsa 1931 because the gular-intergular pattern is not quite that of *E. perfecta*, the type of the genus, and I am not persuaded that the other species referred by Nopcsa to that genus (*E. major*) belongs there. The critical feature of *Elochelys* also, the absence of a suprapygal, is not determinable in Carter's form. A possibly trivial feature, the feeble xiphiplastral notch, distinguishes the Indian fossil from *Stereogenys podocnemoides* (Reinach, 1903), but with Schmidt (1940) I do not believe that *podocnemoides* belongs to the genus *Stereogenys*. *Podocnemoides* and *leithii* may indeed belong to the same genus, but that genus is then unnamed.

From the better defined genera of the Pelomedusidae the Indian form is distinguished by the following combination of characters:

Carteremys, new genus

Type. *Testudo leithii* Carter 1852.

Diagnosis. Skull roof much emarginate from behind; opisthotics prolonged backwards in sharp crests; mandible with a moderately long symphysis; nuchal absent; first vertebral not divided transversely; intergular large and very broad, separating humerals; xiphiplastral notch narrow and shallow; pubic and ischial scars distinctive in shape and position.

* An ingenious device by which Lydekker avoided the possibility of a change in the trivial name of *Dacochelys* has been the source of confusion in regard to this point. The type of the genus is *Dacochelys delabechei* Lydekker 1889, but Lydekker considered his form probably synonymous (largely on size alone) with *Emys conybearii* Owen and therefore (according to Lydekker and Boulenger 1887) with *Emys delabechei* Bell. No name change is necessary *if* this synonymy is correct and, since the shell of *Emys conybearii* shows small lateral mesoplastra (Lydekker and Boulenger 1887), *Dacochelys delabechei* is then a pelomedusine. But the only valid physical type of *Dacochelys* (the type of the species upon which the genus is based) is the very peculiar mandibular symphysis, which I regard as quite impossible to assign to family. Lydekker's device has most unfortunately brought the name *Dacochelys* into the literature (for example in Zangerl, 1948) as a pelomedusine — which it may be but which it certainly cannot at present be proved to be.

It should be mentioned that if *Dacochelys delabechei* were in fact a synonym of *E. delabechei* Bell as Lydekker assumed, and if *E. conybearii* Owen were a synonym of *E. delabechei* Bell as Lydekker also assumed, *Dacochelys* Lydekker 1889 would be a straight synonym of *Palaeaspis* Gray 1870, type *Emys conybearii* Owen

Horizon. Intertrappean Eocene of Bombay.

Comment may now be made on other records and alleged records of this form.

In 1890 Lydekker reported an entoplastron showing half of an intergular scute from the Intertrappean beds in the Nagpur district as a second occurrence of "*Hydraspis leithii*." The new fragment was much larger than typical *Carteremys leithii* and differed also in the much narrower intergular. Lydekker passed over the differences casually with a mention of variability in *Hydraspis* (= *Phrynops*) *hilarii*. It is unlikely that he had in hand any member of the genus *Hydraspis* or *Carteremys leithii*. It is probable that he had some other pelomedusid, and he had himself previously (1887) described a *Podocnemis indica* in the Eocene of India.

Sukheswala (1947, an abstract only) has reported a find of a shell of *Testudo* (= *Carteremys*) *leithii* in the Intertrappean of Worli Hill, Bombay. Here, as in the case of the specimens described by Carter, remains of frogs (*Indobatrachus pusillus*) were associated. In this instance there is no doubt of the identification.

Dr. Sukheswala has kindly sent me a photograph of this specimen (plate 3). The outline of the shell (somewhat different from that figured by Carter) is clearly shown, as is also the characteristic sculpture of the surface (mentioned by Carter), which while somewhat like that of some chelyids also resembles that of, for example, the American pelomedusine genus *Taphrosphys*. More important is the evident presence of several neurals, the first vertebral clearly much smaller than the second, and (less certainly) the absence of a nuchal shield. The plastron and the skull are unfortunately missing. As with Carter's specimens the new shell is small, eight inches long by six wide. The specimen is now in the possession of the Geological Survey of India.

Two other specimens have since been found by Dr. Sukheswala and have been sent by him to the Geological Survey of India. These are recorded in the general report of the Survey for 1948 (West, 1950). These specimens, while recognizable, afford no additional information.

Also recorded by the Survey in the same report was a possible young shell of *Carteremys leithii* from the carbonaceous shales of an Intertrappean band near Raibasa in the Chhindwara district, Central Provinces, India. The Survey has generously sent me a photograph of this specimen. The identification must be pronounced doubtful as, indeed, the Survey has regarded it. While this new locality may be

thought of hopefully, it would appear that *Carteremys leithii* is at present known with certainty only from the Intertrappean of the island of Bombay.

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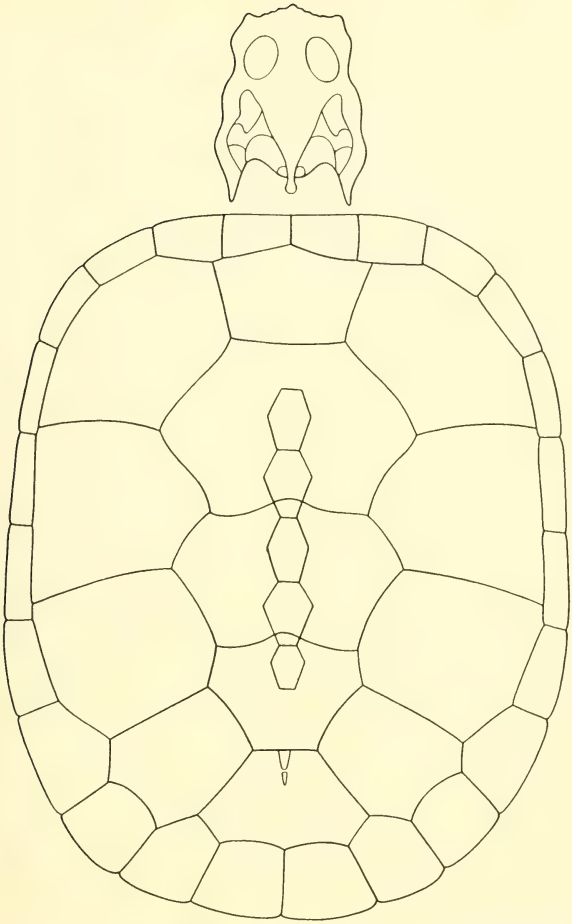

Plate 1. *Carteremys leithii*, dorsal view of shell and skull, slightly modified for clarity from the original reconstruction (Plate X of Carter, 1852). Skull restored from the more perfect half.

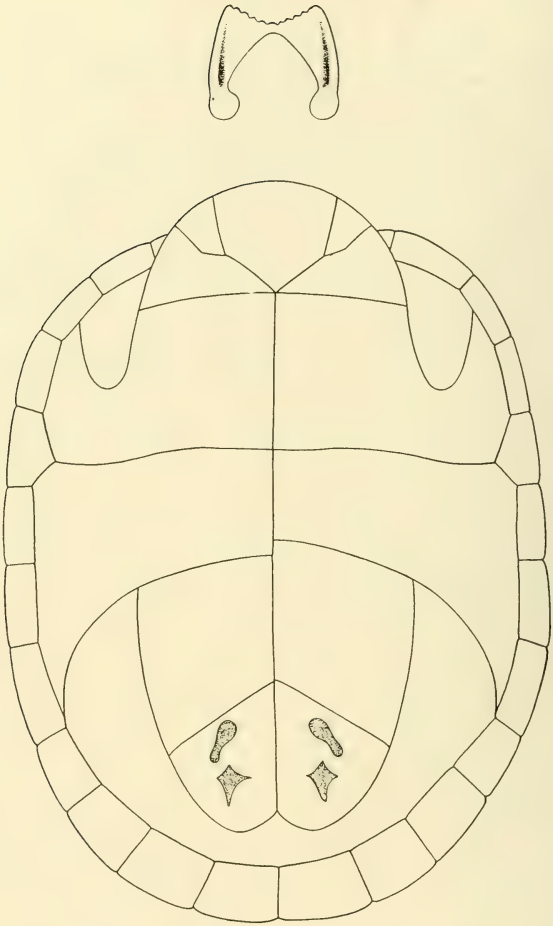

Plate 2. *Carteremys leithii*, ventral view of shell and mandible, slightly modified for clarity from the original reconstruction (Plate XI of Carter, 1852).

Plate 3. *Carteremys leithii*, photograph of dorsal surface of shell. (Courtesy of Dr. R. N. Sukheswala.)

BREVIORA

Museum of Comparative Zoology

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RECORD OF A HERMAPHRODITIC HORSESHOE CRAB, *LIMULUS POLYPHEMUS* L.

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A hermaphroditic horseshoe crab, *Limulus polyphemus* L., was picked up by a small scallop dredge from the channel of Plum Island Sound, Massachusetts on May 16, 1952. As far as can be determined, this is the first such *Limulus* to be recorded.

The general appearance was that of a mature male. Its width (125 mm.) was about average for males in this area. (The widths of 606 mature males measured this summer ranged from 88 mm. to 140 mm., with an average of 117 mm., while 489 mature females ranged from 130 mm. to 199 mm. in width, with an average of 155 mm.) It had mating claspers, and the anterior edge of the prosoma was curved upward in the middle, which also is a male characteristic. The left genital aperture was typically male, round and located on a definite papilla. The right genital aperture was typically female, a horizontal slit and not on a papilla (Lochhead, 1950). The genital operculum, showing both male and female genital apertures, may be seen in the upper illustration of Plate 1. On the dorsal surface of the opisthosoma near the telson were darkened areas normally present on mated females. These may be barely discernible in Plate 2. They are produced by the abrasive action of the anterior edge of the male as he clings tenaciously to the female during the mating period. Females which have mated for prolonged periods exhibit deep scars on the last pair of immobile spines, caused by the powerful claspers of the male.

Such scars were not evident on the hermaphrodite, suggesting that it had been mated as a female for a comparatively short time.

Gross dissection of the prosoma and histological sections revealed both male and female gonads. The right and anterior portions were full of eggs in various stages of development (Plate 2), comparable to to those of mature females. Histological sections of the tissue on the left side demonstrated sperm sacs full of tail-less sperm, diverticula of the hepatopancreas and connective tissue (Plate 1, lower illustration). The same structures were visible in sections of gonads from normal males. According to Benham (1885) the tails are apparently produced as the sperm approach the aperture.

The presence of both eggs and sperm confirms the external evidence that this specimen is a true hermaphrodite.

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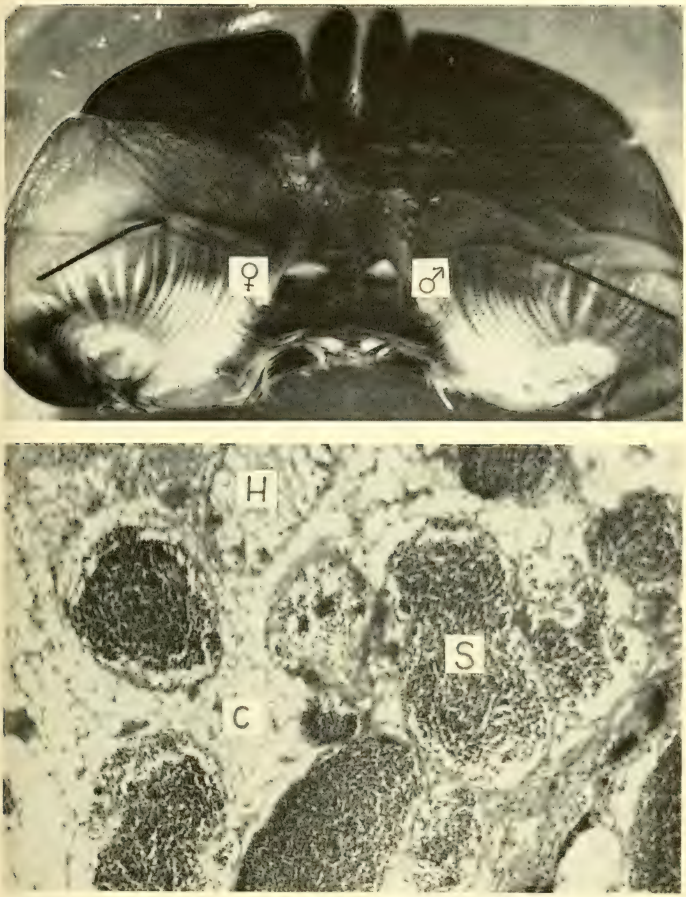

PLATE 1

Upper — Ventral view of posterior surface of genital operculum (enlarged), showing right genital aperture (♀) and left genital aperture (♂).

Lower — Photomicrograph of section through testis (X 120). *S*, sperm sacs containing tail-less sperm. *H*, hepatopancreas. *C*, connective tissue.

(Photographs by Alden P. Stickney)

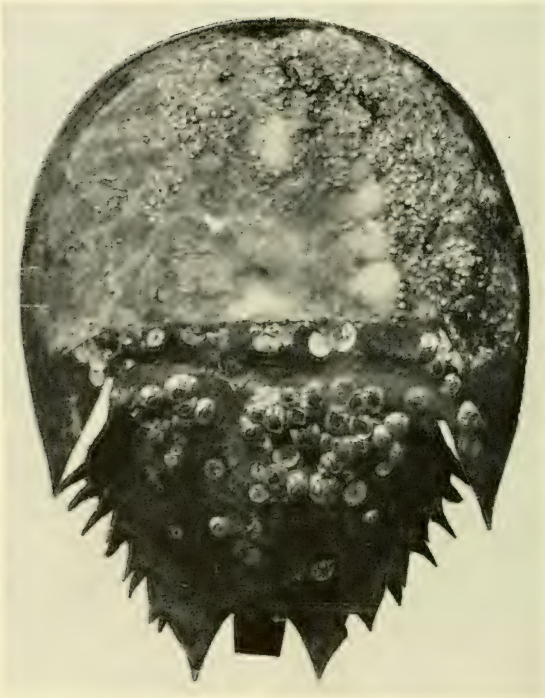

PLATE 2

Dorsal view of *Limulus polyphemus* with carapace of the prosoma removed, showing mass of eggs on the right side, but only a few scattered eggs on the left side. (Telson has been cut off). (Photograph by Alden P. Stickney.)

BREVIORA

Museum of Comparative Zoology

CAMBRIDGE, MASS. MAY 15, 1953 NUMBER 15

FURTHER NOTES ON THE EARTHWORMS OF THE ARNOLD ARBORETUM, BOSTON

BY G. E. GATES

An opportunity to search once more for mature specimens of the *Pheretima* sp., represented in collections of the previous spring by a single, specifically unidentifiable juvenile, was unexpectedly provided on September 25, 1952. After securing the desired material, as many of the previous sites as time permitted were re-examined, to permit comparison of fall with spring populations.

In the natural woods, during the summer, the leaf pile of previous collections had been grown over and had become rather dry. Some fifty feet away, and at about the same distance from the site where the juvenile of *Pheretima* sp. had been found, another large leaf pile, possibly older and with more gravel, had remained damp and without any plant overgrowth. In the peat bog, where vegetation had been mowed and removed, water was no longer running in the brook though still standing in small, scattered puddles, but previously disturbed soil still seemed moist. In the ponds, water level had fallen several inches exposing a marginal strip of bottom muck that was still saturated. The Newton garden had been planted and could not conveniently be re-examined.

The species obtained in the September collections are listed in the following table which also shows sexual stages and number of specimens secured.

EARTHWORMS OBTAINED IN THE ARBORETUM IN SEPTEMBER, 1952

Species	Natural Woods: Original Leaf Pile	Second Leaf Pile: Near Side	Second Leaf Pile: Far Side	Peat Bog
Allolobophora		†	*	
arnoldi	0-2-2	0-1-0	0-0-1	0-0-1
caliginosa	0-0-2			0-0-1
limicola				0-2-0
sp. (1)	4-0-0-0			
Dendrobaena				
subrubicunda	3-5-32	1-0-1		
Eisenia				
foetida	12-5-6	7-1-7	2-0-1	
Lumbricus				
castaneus	0-0-2			
rubellus	3-1-7	2-2-3-16	6-11-17	
terrestris	4-1-0-4		1-0-1	
Octolasium				
lacteum				0-0-1
Pheretima				
agrestis		0-0-35	0-0-21	

Figures indicate juvenile-aclitellate-clitellate or small juvenile-late juvenile-aclitellate-clitellate.

† Postsexual aclitellate.

* Specimen in poor condition.

(1) Probably of *arnoldi* and/or *caliginosa*.

A. arnoldi. Two specimens from original leaf pile listed as clitellate had spermatophores externally but the clitellum had almost completely regressed, the site being indicated only by a brownish discoloration. In an amputee from the bog, after enteroparietal healing at 106/107, cvi had been much elongated and at the same time narrowed so as to taper terminally and its setae had been lost though follicle apertures were still visible. One worm from the leaf pile showed the same changes in its last segment.

L. terrestris. A small juvenile from the leaf pile, 27 x 2.5 mm. has 149 segments.

O. lacteum. Segments in front of the anus were packed with coelomic corpuscles and parasitic bodies many of which were discharged through dorsal pores during preservation.

Dendrobaena subrubicunda (Eisen) 1874

Clitellum, on xxvi–xxxi but occasionally with slight extension onto xxxii (32 + 26), xxvi–xxxii (1). Epidermis of xxv (several + 8) and xxxii (several) slightly modified. Tubercula pubertates, on xxviii–xxx (35 + 27), occasionally reaching onto xxxi. Each tuberculum nearly always is bounded laterally by a deep groove. In two clitellate specimens in which tubercula were quite indistinguishable the groove was obvious, on both sides of the body. The tuberculum is longitudinally elliptical in outline. A central depressed portion of similar outline may be more or less clearly demarcated from a band-like marginal area by a slight groove, or, instead, there may be recognizable only a single longitudinal groove at the center. The lateral groove, in some specimens, apparently passes, though less clearly, around ends of tuberculum to become completely circumferential. Genital tumescences, including *ab*, on viii (5), ix (14 + 11), x (5), xvi (33 + 27), xvii (2 + 1), xviii (1), xx (3), xxi (1), xxii (+1), xxiii (+2), xxiv (12 + 12), xxv (1 + 3), xxvi (+1), xxvii (26 + 25), xxviii (2), xxxi (19 + 23), xxxii (1), xxxiii (+1), xxxiv (+1), xxxv (+1). Tumescences on xvi may extend well into *bc* and *aa* or even be united mesially. Those on xxxii to xxxv are especially well developed.

Homoeosis. Male pores, on xvi. Female pores, on xiv. Clitellum, on xxvi–xxxii and on xxxiii–xxxiv of left side only. Tubercula pubertates, on xxviii–xxx (right side), xxix–xxxiii (left side). Genital tumescences, on left sides of xxiv and xxxiv. No metameric abnormality recognized.

Remarks. In live worms a short terminal region had a brilliant yellow appearance that disappeared during preservation and which, presumably, was due to accumulations of coelomocytes in the coelomic cavities of a region with rather transparent parietes. The anal region was not marked off by an intersegmental furrow from the last setigerous segment in 19 specimens. Spermatophores were present externally on eight specimens.

Data from a series of 27 specimens (collected at Bangor, Maine) that has been available for comparison with arboretum worms, are included in parentheses above, preceded by the + sign. Very little of such information has been reported.

Lumbricus rubellus Hoffmeister 1845

Number of segments: 67, 73, 75, 79, 85, 88, 91, 96, 100, 101. 109 (2), 110, 111, 112 (4), 113 (3), 114 (3), 115 (2), 116 (3), 117 (4), 118 (3), 119 (4). Clitellum, on xxvii–xxxii (40). Tubercula pubertates, on xxviii xxxi (5), but extending onto xxvii (40). Genital tumescences, including *ab*, on vi? (1), vii? (1), viii (2), x (6), xi (42), xii (50), xxvi (56), xxvii (3).

Abnormality. No. 1. One segment near the hind end split, on opposite side, into three segments each with setae. No. 2. Two metameric abnormalities in region shortly in front of anus.

Homoeosis. No. 1. Male pores, as well as female, on xiv. No. 2. Male pores on xvi, female pores on xiv. Clitellum on xxvii–xxxii, tubercula on xxviii–xxxi but extending onto xxvii. Genital tumescences, on xxvi, and possibly also (?) on vii–xiii. No. 3. Female pores on right side of xiii and left side of xiv. Male pores on right side of xiv and left side of xv. Aclitellate, tubercula on right side of xxvi xxx and left side of xxvii–xxxi. Genital tumescences, on right sides of ix and xxv, left sides of x and xxvi.

Remarks. Worms with 79, 88, and 100 segments have large nephropores, pit-like depressions at sites of apertures of setal follicles but no setae on the last segment, and probably were amputees. Two specimens, of 109 and 119 segments, had setae in the last segment and presumably were also amputees. If any of the other worms having 67 to 101 segments are amputees, no indications thereof were recognized and the terminal region must have been subsequently reorganized so as to look like that of a normal worm.

In the clitellar region, intersegmental furrows are always more or less clearly indicated. The worms can be arranged in a finely graded series of stages showing gradual deepening of the furrows, decrease in thickness of the epidermis, reappearance of dorsal pores, and gradual reddening of the parietes. In the final stage, boundaries of the clitellum were not certainly determinable but in much of the clitellar region the red color has a sort of slight whitening that is lacking on other segments. No spermatophores were found. No brownish discoloration such as is present in the clitellar region of postsexual specimens of some species, was recognized in any of the worms.

Smith (1917) and Olson (repeatedly) have given the number of

segments in this species as 95 to 150 or 90 to 145, but with no data as to individual counts in American specimens. Segment numbers in all of the arboretum collections are in better agreement with those of English worms, 95 to 120, as reported by Cernosvitov and Evans (1947).

Pheretima agrestis Goto and Hatai 1899

External characteristics. Length, 70–150 mm. Diameter, 5–8 mm. Number of segments: 63 (3***), 64 (*), 66 (2**), 67, 69 (*), 71, 76, 77, 78 (2**), 82, 84, 85 (*), 86, 90, 92 (2**), 95, 97 (2), 98 (2), 99 (3), 100 (7), 101 (6), 102 (7), 103 (5), 104 (1). First dorsal pore, on 12/13 (56); a dark and somewhat pore-like marking shortly behind 11/12 on several specimens, definitely on 11/12 though not a functional pore, in one worm. Setae: 52, 55, 56, 62, 62, 64, 64, 65, 69/xii; vii/2, 4, 4, 3, 4, 2, 1, 1, 1, 2, 2, 4, 2, 4, 4, 1, 2, 1, 3, 2, 2; viii/5, 3, 5, 1, 2, 2, 3, 0, 2, 2, 2, 5, 3, 4, 3, 0, 0, 0, 1, 1. (Clitellum, on xiv–xvi; annular.)

Sexthecal, spermathecal pores minute and superficial, on 5/6–7/8, about $\frac{1}{2}$C apart. Each pore may be at center of a definitely demarcated circular porophore or the latter may have the appearance of two semicircles, one in front of and the other behind the pore. (Female pore, single, median, on xiv.) Male porophores, male pores, as well as any rudiments thereof, completely lacking.

Definite genital markings also are lacking. The setal circles of vii–viii are uninterrupted (several specimens), or have a small gap on one side (several) or one large median gap which may extend nearly to spermathecal pore lines (25), or a pair of gaps leaving a few setae midventrally (as indicated above). In the latter case, in ten specimens, in region of each setal gap there is recognizable, in good optical conditions, an area where the epidermis is thin or especially cross-hatched with fine furrows. These areas, which have no definite boundary though appearing to be of transversely elliptical outline, are symmetrically placed across the setal equator. No special pigment, brown or otherwise, was recognized in any of those areas.

Internal anatomy. A low collar of iridescent tissue is present on the oesophagus just behind the gizzard. The intestine begins in xv (6) and has a double row of sacculations on each side from about xvi to about xxv, the ventral row on each side usually more definite than the dorsal and with one or more of the sacculations so constricted as to have an appearance of dorsally directed pockets. The caeca are mani-

cate, with seven or eight secondary caeca, the dorsalmost the longest. The typhlosole, which begins in the region of the caecal segment, is low, simply lamelliform and from about xxxix gradually decreases in height, becoming more irregular in shape and finally unrecognizable behind lxvi (worm of 92 segments), lxxiv (100, 104 segments), lxxvii (102 segments). A very small but definite and double ridge runs posteriorly on the floor of the gut from the caecal metamere for fifteen or twenty segments.

Last hearts in xiii (5), heart of ix on left side (3) or right side (2), hearts of x lacking (5). Subneural trunk much smaller anterior to xiii but continued into ii. The dorsal trunk of one specimen passes superficially through tissues of the pharyngeal bulb and on emerging anteriorly bifurcates under the brain, the branches passing around the gut median to the nervous commissures and reuniting midventrally to become the ventral trunk.

Testis sacs unpaired, apparently above the nerve cord and with ventral blood vessel in, on or just above the roof. Testes present, male funnels large and nearly filling the sacs which have very little coagulum. Seminal vesicles laterally flattened, filling coelomic cavities of xi and xii, reaching into contact with dorsal vessel, in xii with a primary ampulla marked off distinctly from the lamina. Vasa deferentia, in region of xvi to xxiv, slightly swollen for a short distance and ending blindly without passing into parietes. No trace of male terminalia. Ovaries appear to be unusually large.

Spermathecal ducts shorter than contracted ampullae, with thick wall (having a muscular sheen), abruptly narrowed at parietes, lumen in coelomic portion large, irregularly slit-like in cross section as a result of presence of high longitudinal ridges. Diverticulum longer than combined lengths of duct and ampulla, into median face of duct close to parietes, with slender stalk (having muscular sheen) longer than the duct and a longer, more or less sausage-shaped seminal chamber.

Distribution. Japan: Takahashi, Tokorosawa, Oarai, Sapporo, Hokkaido, Sendai, Oshima Island, Matsuyama, Tomitaka, Kagoshima. Said to be widely distributed throughout the Aomori and Iawati prefectures. *P. agrestis* has been reported once before outside of Japan and then from Baltimore but several attempts to secure specimens for confirmation of the identification have been fruitless.

Abnormality. Specimen of 82 segments with one metameric abnor-

mality in region of lii. First dorsal pore on 12/13 but a definitely pore-like though obviously non-functional marking exactly on 11/12. Left spermathecal pore of 7/8 and clitellum on right side of xiv lacking. Female pores: on left side of xiii, in setal circle, and on right side of xv. Heart present in xiv on right side. A testis on posterior face of left rudiment of 8/9, a male funnel on anterior face of left rudiment of 9/10 (no testis sac but sacs and vesicles of x–xii as usual. Left ovary lacking but a rudimentary female funnel present in left side of xii; right ovary and female funnel in xiv. Vasa deferentia end blindly in xxiv.

Autotomy and *Regeneration*. On being touched three worms instantly autotomized a posterior portion (of 31, 34, 35 segments). In one case autotomy was either through lxiv or at 64/65. In a specimen of 85 segments, lxii–lxiii were deeply constricted all around the body but apparently without recognizable break in the musculature. Posterior amputees are indicated above by asterisks after setal numbers (one for each amputee). Specimens with 63, 69, 77, 78, 86, 90 and 92 segments each have an anal region that is not marked off by an intersegmental furrow from a terminal segment with a complete circle of setae. The last metamere in a 78-segment worm (a) is unusually long, without setae, but with minute pits still representing sites of apertures of original follicles. A similar long terminal metamere but without setal pits characterizes a worm (b) of 76 segments but in this case setae are recognizable, in the penultimate metamere, only within the parietes of the ventrum. Tail regenerates, in spite of the high incidence of posterior amputation, were not found.

In the (a) worm, loss of setae with resorption of setal follicles, and elongation of the last segment, are regarded as external indications of a process of reorganization, as one result of which a new growth region, in addition to an anus, is reestablished in place of that which had been lost by amputation. In the (b) worm the penultimate segment is regarded as one that had already been marked off (by an intersegmental furrow from a reestablished growth region), but in which equatorial setae, one of the stigmata of a metamere, had not yet been sufficiently developed to be externally visible except in the ventrum. Differentiation of the new metamere had not yet been fully completed. Further, the length of the terminal (growth) region is such as to indicate possibility of production of yet another segment. If these interpretations are correct, *P. agrestis* presumably does not, at least ordinarily replace lost posterior portions at levels behind 62/63

by the supposedly usual process of tail regeneration. Instead, a growth zone is reconstituted that may produce new segments, but only slowly and one at a time. In new segments so produced, the usual differential stigmata of regeneration, so easily recognizable in long tail regenerates that have been produced by a much more rapid process, may well be lacking.

The penultimate segment (counting anal region as a segment), in several specimens that presumably had not undergone posterior amputation, had no externally visible setae and no vestiges of former setal pits were recognizable. Both ante- and pen-ultimate segments in another specimen (of 100 segments) were similarly incompletely differentiated. In the rather small anal region of two specimens (of 100 segments each), a short rudiment of an intersegmental furrow is present, in the ventrum (1) or dorsum and then with a rudiment of a dorsal pore. These conditions are regarded as indicating that new segments may be produced, even in unamputated adults, by a slow, one-at-a-time method.

Remarks. The clitellum seems to be fully developed in every specimen. Nevertheless no spermatozoal iridescence was noticed on any male funnel of the six dissected specimens. Nor was spermatozoal iridescence recognizable in any of the thirty-five spermathecae. If sperm are produced they cannot, in absence of male terminalia, be transferred to another individual in copulation. Every specimen in a fair-sized sample being anarsenosomphic, reproduction must take place by self fertilization or parthenogenesis, with the latter more likely because of apparent absence of mature sperm in the probable breeding season. In either case, introduction of a single worm, even a single cocoon, theoretically could have enabled establishment of *P. agrestis* in the arboretum.

Presence of a full set of seminal vesicles, and of a complete battery of spermathecae, all now of no apparent use in reproduction, on a principle of economy, indicates that the anarsenosomphic development in this species has been recent.

DISCUSSION

During the summer the population of the pond periphery quite obviously had increased considerably. Exposed but still saturated margins were almost covered with castings of *Sparganophilus eiseni*,

the only species found (the *rubellus* sites, just at the high water level not re-examined).

In the original leaf pile, *E. rosea* apparently had disappeared, and two species, *E. foetida* and *D. subrubicunda*, absent in the spring, had appeared. One of them, *D. subrubicunda*, had become dominant numerically. *L. terrestris*, however, still remained dominant by sheer volume even though not as common as in the spring.

From the earth of the original peat bog site all worms had been removed in the spring. Several weeks later more than fifty specimens had moved into the disturbed soil from below or round about. Although that same soil still appeared moist in September only seven worms were found in it. Three species, *E. rosea*, *E. tetraedra* and *L. rubellus* were no longer represented, but two, *O. lacteum* and *L. terrestris*, that had been lacking at time of second collecting were again present.

In the newly examined leaf pile, *Pheretima agrestis*, an exotic from Japan (and possibly brought directly from there) was clearly dominant by weight though equalled in numbers by *L. rubellus*.

No cocoons or copulating individuals of any species were found in fall collecting. A clitellum sufficiently mature for cocoon deposition apparently characterized specimens of *L. terrestris*, *O. lacteum*, *D. subrubicunda*, *P. agrestis* and *E. foetida* but appearance of the clitellar region indicated that the reproductive period had ended in *A. arnoldi* and *L. rubellus*. Breeding period in *P. agrestis* is probably in the fall.

ACKNOWLEDGMENTS

The collecting and identifying of the material considered in this contribution constituted spare time recreation during part of a fellowship period. The author's thanks are extended to the John Simon Guggenheim Foundation for making this contribution possible and to the Director of the Arnold Arboretum for permission to collect therein.

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NOTES ON THE RACES OF *Micrurus frontalis* (Duméril, Duméril and Bibron)

BY BENJAMIN SHREVE

As *Micrurus frontalis* and its associated forms appeared in need of revision, 46 specimens were assembled for the purpose. This total consisted of all the material in the Museum of Comparative Zoology (M.C.Z.), two specimens from the American Museum of Natural History (A.M.N.H.), and all those in the Chicago Natural History Museum (C.N.H.M.).

It was found that the material fell into three groups: *M. f. frontalis* (21 ex.), *M. f. altirostris* (21 ex.), and *M. f. pyrrhocryptus* (4 ex.).

I have retained *altirostris* as a race of *frontalis* as evidence is lacking that the two do not have separate ranges joined by an area where both occur together and interbreed, although the supposed area of hybridization is decidedly large and there is doubt how much, if any, interbreeding occurs within it. Further discussion of this matter is presented below.

I regard *pyrrhocryptus* as a race owing to its close relationship to *frontalis* and the fact that it apparently has a range separate from either *altirostris* or *frontalis*.

This opportunity is taken to thank the curators, Messrs. C. M. Bogert, C. H. Pope and K. P. Schmidt, for these loans, also Mr. K. P. Schmidt for furnishing data on a *pyrrhocryptus* belonging to the American Museum of Natural History. I also wish to thank Mr. Arthur Loveridge for furnishing data on the head coloration of the Uruguay series of *altirostris* in the British Museum (N.H.).

Key to the Subspecies

1. Parietals without pale area except sometimes along the anterior border; triads on body 7–15; ventrals 216–242 2
   Parietals exhibit a pale area at least anteriorly; triads on body 13–17 (13 only rarely)[1]; ventrals (197) 203–220 ..... *altirostris*
2. Light nuchal area between posterior end of parietal suture and first black ring from ½ to 3½ scales in width; body triads 9–15 (9-10 only rarely), black median ring of triad usually not broader or but little broader than the black outer rings ..... *frontalis*
   Light nuchal area between posterior end of parietal suture and first black ring from 5½ to 8 scales in width; body triads 7–9, black median ring of triad usually twice as broad as the black outer rings. . *pyrrhocryptus*

MICRURUS FRONTALIS ALTIROSTRIS (Cope)

Elaps altirostris Cope, 1859, Proc. Acad. Nat. Sci. Philadelphia, p. 345: Type locality unknown.

Schmidt (1936, p. 199) gives the type locality as South America, but there is nothing to suggest this in the description or title of Cope's article.

Range. Uruguay (where *frontalis* is apparently unknown). Outside of Uruguay, except where otherwise noted, it occurs alongside *frontalis* with which it may possibly hybridize. It also occurs in the Brasilian states of Rio Grande do Sul, Paraná, São Paulo (probably also in Santa Catarina and southern Mato Grosso). In Argentina it occurs in the Gobernación of Misiones (probably also in Corrientes Province and possibly those of Entrerios and Buenos Aires, as well as Paraguay).

Material examined. ARGENTINA: Misiones: Iguazu Falls (C.N.H.M. 9260–2, 9383–4), Monte Carlo (C.N.H.M. 9357). BRASIL: Paraná: eastern part (C.N.H.M. 37736–7, 37743–4), Pinheiro Machado (M.C.Z. 51495); Rio Grande do Sul: Itaquí (M.C.Z. 17853), Nova Teutonia (C.N.H.M. 16121–2, 18475), Pelotas (M.C.Z. 27651), Santa Maria (M.C.Z. 43337–9); State of São Paulo (M.C.Z. 20848), eastern part (C.N.H.M. 37742).

Ventrals (197) 203–219 in ♂♂, (206) 208–220 in ♀♀; subcaudals (16) 19–25 in ♂♂, (16) 18–23 in ♀♀; also ventrals 215–220, subcaudals 19–22 in two unsexed juveniles; body triads 13–17; total length: largest ♂ (M.C.Z. 20848) 918 (859 + 59) mm.; largest ♀ (C.N.H.M. 37737) 881 (834 + 47) mm.

[1] 12–15 body triads according to Boulenger (1896, p. 428) on Uruguay snakes he assigned to *Elaps frontalis*, but which are probably *altirostris*.

As regards the possibility of hybridization between *altirostris* and *frontalis*, it has not reached a point where doubts are raised as to the assignment of any individual. For example, an *altirostris* ♀ (C.N. H.M. 37736) from eastern Paraná has the pale area on the anterior part of the parietals reduced, though otherwise the dark head markings, except for being rather brownish, are those of *altirostris*. The body triads are 16, which is higher than in any *frontalis;* ventrals 217.

Only one *frontalis*, a Nueva Italia ♂ (M.C.Z. 47028) with 216 ventrals has so low a count, possibly resulting from an admixture of *altirostris* "blood". Admixture with *frontalis* is further suggested by a ♀ (C.N.H.M. 37737) and juvenile (C.N.H.M. 9261) *altirostris* with 220 ventrals, as well as by other material. Further support for the idea of hybridization is afforded by the ventral and subcaudal counts of Uruguayan *altirostris* which, being presumably free from association with *frontalis*, average lower than those from elsewhere. It seemed likely that all Uruguayan *altirostris* might have almost entirely white parietals such as is found in an apparently pure bred ♂ (C.N.H.M. 16121) from Brasil, whose ventrals number 204, subcaudals 21, and body triads 15, but an examination of the Uruguay series in the British Museum by Arthur Loveridge reveals that they are as variable in this character as many from elsewhere.

The tendency for one form to show one or more characters of the other may be due to individual variation in the nature of a "throw back" to more primitive characters. In this event possibly hybridization does not occur and the two forms should be treated as specifically distinct, a course which probably also should be followed if limited hybridization occurs.

Available material is insufficient to allow of a definite opinion, but I incline to the theory of hybridization which is possibly limited by some factor such as infertility of the resulting offspring. The evidence is against general hybridization, though the two forms occur in many Brasilian states and elsewhere as the following figures show. Where the number of specimens is small those from several areas are grouped together, and all arranged from North to South so that a comparison may be made of the varying incidence of the two forms.

	altirostris	*frontalis*
Bahia?; Minas Gerais; Rio de Janeiro	0	5
São Paulo	2	11

Paraná	5	2
Misiones, Argentina; Villeta, Paraguay	6	1
Rio Grande do Sul	8	2

M. lemniscatus multicinctus Amaral (1944, p. 91), with Teixeira, Soares, Paraná, Brasil, as a type locality, appears to be a composite of *altirostris* and *frontalis*. It is not known which of the two the type might be.

Micrurus frontalis frontalis (Duméril, Duméril and Bibron)

Elaps Frontalis Duméril, Duméril and Bibron, 1854, Erp. Gen., **7**, p. 1223: Brasil (part).

The type locality would appear to be Brasil, rather than Corrientes and Misiones, Argentina, as given by Schmidt (1936, p. 199), for Claussen's two Brasilian specimens appear to be the only ones whose description conforms to *frontalis* (*sensu stricto*) as currently regarded. The rest of the material listed under this form in the Paris Museum is apparently *altirostris*. It is interesting to note that Boulenger (1896, p. 428) lists three Brasilian *frontalis* in the British Museum from Clausen (*sic*). (Actually it is not known which way the name should be spelled.) Dr. P. E. Vanzolini tells me that Claussen collected in Lagoa Santa, Minas Gerais; so that is probably the type locality of *frontalis*.

Range. Southern Brasil, where it is known from: southern[1] Bahia?, Minas Gerais, Rio de Janeiro (possibly also Espirito Santo and southern Goias, *altirostris* being apparently unknown and not expected to occur in these five states), São Paulo, Paraná, Rio Grande do Sul (probably also southern Mato Grosso and Santa Catarina); Paraguay; while in Argentina it probably occurs in the Province of Buenos Aires; and possibly those of Corrientes and Entrerios and the Gobernación of Misiones.

Material examined. Brasil: Bahia?: Santa Cruz (M.C.Z. 3298); Minas Gerais: Belo Horizonte (M.C.Z. 13954, A.M.N.H. 22573), Uberaba (M.C.Z. 12698); State of Paraná (C.N.H.M. 37206–7); Rio Grande do Sul: Itaquí (M.C.Z. 17854), Pelotas (M.C.Z. 27652): State of Rio de Janeiro: Rio de Janeiro (M.C.Z. 1375); State of São Paulo (M.C.Z. 12699, 16684, 20844–7, 20849–50), eastern part (C.N.H.M. 37738), Butantan (M.C.Z. 17759–60). Paraguay: Villeta: Colonia Nueva Italia (M.C.Z. 47028).

[1] As M.C.Z. 3298 is only labelled Santa Cruz, Brasil, it is uncertain whether it came from Bahia or one of the other states.

Ventrals 216–236 in ♂♂, 221–242 in ♀♀; subcaudals 20–26 in ♂♂, 17–23 in ♀♀; body triads 9–15; total length: largest ♂ (M.C.Z. 27652) 1121 (1058 + 63) mm., largest ♀ (M.C.Z. 13954) 860 (819 + 41) mm.

The possibility of hybridization between *frontalis* and *altirostris* has already been dealt with under the latter. Comparison of *frontalis* from different parts of its range furnished no grounds for present recognition of further subspecies to those enumerated here. However, some variation was noted. The light bands of the triads, normally 2 or 3 scales in width, are about 4 or 5 scales in width in a Rio de Janeiro ♂ (M.C.Z. 1375). São Paulo snakes tend to have more body triads than specimens from elsewhere, the counts not overlapping with those of more northern snakes but overlapping with more southerly ones; these counts in turn overlap with those of northern snakes. In the event of a further race being recognizable, the availability of Amaral's *multicinctus* should not be overlooked.

I follow Schmidt (1936, p. 199) in regarding *Elaps baliocoryphus* Cope (1859, p. 346) as a synonym of *frontalis frontalis*.

Micrurus frontalis pyrrhocryptus (Cope)

Elaps pyrrhocryptus Cope, 1862, Proc. Acad. Nat. Sci. Philadelphia, p. 347: Vermejo River, Chaco, Argentina (*ex* Schmidt, 1936).

Range. Northern Argentina, where it is known from Mendoza and Cordoba provinces, and likely to occur in the intermediate areas between them and the Department of Santa Cruz, Bolivia, from which area it is known. Probably occurs east to the Paraguay River and east to the Paraná River below its confluence with the Paraguay. Note also the type locality.

Material examined. Argentina: (A.M.N.H. 17592); Province of Mendoza (M.C.Z. 15911–2). Bolivia: Santa Cruz: Buenavista, 450 meters (M.C.Z. 20622).

Ventrals 224–232 in ♂♂, 228–(231) in ♀♀; subcaudals 24–25 in ♂♂, 24–? (tail truncated) in ♀♀; ventrals about 225 and subcaudals 25 in an unsexed juvenile. Subcaudals appear to average slightly higher than in the other races. The count in parenthesis is that of a ♀ (A.M.N.H. 65273) from La Cumbre, Cordoba, Argentina, kindly supplied by Mr. K. P. Schmidt. Body triads 7–9; total length: largest ♂ (A.M.N.H. 17592) 948 (896 + 52) mm., largest ♀ (M.C.Z. 20622) 955 (900 + 55) mm.

The median black ring in the Bolivian example is not as wide in relation to the other two black rings of a triad as in the two Mendoza snakes, and it has one triad more than in any others counted. Whether this is an indication of a Bolivian race remains to be seen.

It is probable that the ranges of all three races are more extensive than here indicated, at least in Argentina, according to Serié (1936, pp. 52, 53 and 55) whose nomenclature differs, but from whose descriptions it is possible to deduce with some degree of certainty which of the forms he had in hand.

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BREVIORA

Museum of Comparative Zoology

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A NEW ORDOVICIAN TRILOBITE FROM FLORIDA

BY H. B. WHITTINGTON

Introduction. The trilobite described below came from a core recovered from a deep well in Madison County, Florida. It is the only trilobite found in the numerous wells that have penetrated the Palaeozoic of Florida, and is relatively complete. Of special interest is its relationship to trilobites of central and southern Europe and northwest Africa (not with any so far known in North America), and its being by far the earliest calymenid to appear in North America. I am indebted to Dr. J. Bridge, U. S. Geological Survey, for inviting me to study the specimen, and to Drs. Bridge and Jean M. Berdan for allowing me access to the results of their preliminary study of the Palaeozoic rocks from test wells in Florida and adjacent parts of Georgia and Alabama. The advice on the identification of the trilobite offered by Dr. C. J. Stubblefield, Geological Survey of Great Britain, is gratefully acknowledged.

Age. The Florida trilobite is here regarded as related to early representatives of the calymenid-homalonotid groups, in particular to species of *Colpocoryphe*, but less closely to *Placsiacomia*. The former genus occurs in strata of Llanvirn (and probably early Llandeilo) age in Bohemia and Thüringia (R. and E. Richter, 1927), northwestern France (Rouault, 1849; Barrois, 1900), Portugal (Delgado, 1908), central Spain (Verneuil and Barrande, 1855), Morocco and Algeria (Gigout, 1949; G. and H. Termier, 1950). *Placsiacomia* occurs in younger strata, of Llandeilo age, in Bohemia and possibly Normandy (Prantl and Přibyl, 1948). The Florida strata may therefore be of Llanvirn-Llandeilo age, i. e. in North American terms approximately late Canadian or early Champlainian.

Paleogeographical Implications. Evidence brought forward recently by Harrington and Kay (1951) and Wilson (1952) has served to strengthen the impression that the early Ordovician faunas of South America, the Ouachita and Appalachian troughs, and northwestern Europe belong to the same general province. This likeness, at least between the Appalachians, Ireland, Scotland, and the Baltic, continues into Middle Ordovician times (cf. Stubblefield, 1939, pp. 57–60). Ordovician faunas of central and southern Europe (including West Shropshire and South Wales), and especially those of Llanvirn-Llandeilo time, include a characteristic group of genera, elements of which are rare or unknown farther north and west, i.e. in Scotland, Ireland, and the Appalachians (cf. Stubblefield, 1939, pp. 52–55). The Florida trilobite seems to be a lone representative of this more southerly fauna, and its presence may indicate that the Florida Palaeozoic rocks were laid down in a province faunally separated from that of the Appalachian-Ouachita trough (cf. King, 1950, pp. 657–658). In addition, Professor H. J. Harrington, University of Buenos Aires, informs me (personal communication) that the Florida trilobite is unlike any known in South America.

The oldest calymenid-homalonotid trilobites so far known in the Appalachian trough (and elsewhere in North America) are *Flexicalymene* and "*Brongniartella*", from Trentonian rocks of late Champlainian time. This is much later than the first appearance of calymenids in Lower Ordovician deposits of England and Wales, and considerably younger than the presumed age of the Florida strata in question. Thus the Florida trilobite is a representative not only of a different faunal province but of the earliest calymenids in North America. On the other hand, the Ordovician of Florida is a clastic sandstone and shale sequence, dark in color, not unlike the Llanvirn-Llandeilo sediments of central European areas. The occurrence of a "Bohemian" type trilobite in Florida may be because of the suitable environment there, rather than because of the existence of some other type of barrier to faunal migration between Florida and the Appalachian province.

SYSTEMATIC DESCRIPTION

Family CALYMENIDAE Milne Edwards, 1840.

Genus Colpocoryphe Novák *in* Novák and Perner, 1918.

Type species. *Calymene arago* Rouault, 1849, from the Ordovician (Llandeilo) of north-western France.

Discussion. The outline of the glabella, position of eyes, thorax of 13 bluntly-terminated segments, and triangular pygidium combine to suggest that the Florida specimen belongs with the calymenid-homalonotid group of trilobites, which appears in Lower Ordovician times. It was first compared with illustrations of the homalonotid *Placsiacomia rara* Hawle and Corda, 1847 (p. 55, Pl. 3, fig. 30; see also Barrande, 1852, pp. 581–582, Pl. 29, figs. 21, 22; 1872, p. 40, Pl. 5, fig. 27; Prantl and Přibyl, 1948, pp. 19–21, Pl. 2, fig. 6). The outline of the glabella, presence of two faintly defined pairs of lateral lobes, position of the eyes (far outwards and forwards), form of the thoracic segments and pygidium, are strikingly similar. *P. rara* is distinguished by the angulate outline of the pseudo-frontal glabellar lobe, the lack of ring furrows in the pygidial axis, lack of broad border and border furrow on the pleural lobes of the pygidium, and presence of the first pair of pygidial pleural furrows. The "small circular elevation" on the inner posterior part of the fixed cheek of *P. rara*, mentioned by Prantl and Přibyl (1948, p. 19), is apparently not present in the Florida specimen.

Dr. C. J. Stubblefield (personal communication) suggested that the Florida trilobite should also be compared with species of the calymenid *Colpocoryphe* Novák, 1918 (*in* Novák and Perner, 1918), and especially with *C. inopinata* Novák (*in* Pompeckj, 1898, p. 249; see also Novák and Perner, 1918, p. 37, Pl. 4, figs. 1–16; R. and E. Richter, 1927, pp. 73–75, Pl. 5, figs. 10, 11). The pygidium of *Colpocoryphe* is characteristic, the axis showing several ring furrows, the pleural lobes with few, faint pleural furrows, but with a broad, gently convex border. The border furrow runs from about the mid-point of the anterior margin of the pleural lobe, sub-parallel to the margin, to abut against the tip of the axis (e.g. Barrande, 1872, Pl. 2, figs. 35, 39). The Florida trilobite has this type of pygidium. The cephalon, however, differs from that of *C. arago* (Barrande, 1872, Pl. 2, figs. 34, 35; Pl. 8, figs. 11, 12) in that the eye is farther forwards and outwards, and the glabella lacks the deep glabellar furrows and well-defined lateral lobes. The cephalon of *C. inopinata* has the eyes as far out and forwards as the Florida specimen, and the glabellar furrows are faint, the lobes lacking independent convexity. Thus the Florida trilobite, while it bears a considerable resemblance to *Placsiacomia rara*, has the distinctive

pygidium of *Colpocoryphe*, and the cephalon is like that of one species of the latter. It is therefore placed in *Colpocoryphe*, and regarded as a distinct species.

Colpocoryphe exsul sp. nov.

Pl. , figs. 1, 2.

Holotype. External mould in dark-grey, micaceous shale from core taken between 5154 and 5162 feet depth in Hunt Oil Company's J. W. Gibson No. 2 well, sec. 6, T 1S, R 10E., Madison County, Florida. This well was drilled in May, 1944, surface elevation 107 ft., and reached the top of the Palaeozoic rocks, beneath probable Lower Cretaceous rocks, at 4628 ft. depth. The total depth drilled to was 5381 feet, so that 753 feet of Palaeozoic rocks were passed through, mainly dark shale, some sandstones.

Geological Horizon. Late Lower or early Middle Ordovician (see above).

Description. Glabella of length (sagittal) 3.7 mm., maximum width immediately in front of occipital ring 3.8 mm., narrowing to 1.6 mm. across pseudo-frontal lobe, gently convex, antero-lateral margins straight, anterior margin bluntly rounded. Occipital ring .17 mm. long (sagittal), defined by a shallow furrow curving slightly forwards to the mid-line, deeper in the outer part. In front of the outer one-third of the occipital furrow is a low, narrow, transversely-directed inflation, strongest at the inner end, dying out distally. In front of this inflation the basal glabellar lobe is exceedingly faintly outlined, the first furrows commencing at the mid-length and running diagonally inwards to about one-third the width. The posterior edge of the lobe is defined by the transverse inflation. Second glabellar lobes are indicated by the second furrows, commencing at one-third the glabellar length, running parallel to the first and extending in to one-third the width at that point. Axial furrows deep, continuous with deep, preglabellar furrow. Fixed cheeks gently convex, broad, outer parts and borders not preserved. Anterior to the glabella a sagittally short preglabellar field is continuous with the cheeks, and the anterior margin of this field (probably the rostral suture) is a curve concave forwards, so that the length (longitudinal) of the preglabellar field increases outwards from the mid-line. Right palpebral lobe represented by a small, low swelling at the margin of the fixed cheek, situated

in line with the preglabellar furrow and 1.6 mm. out from the anterolateral corner of the glabella.

Thorax of 13 segments. Axial ring of second segment 2.7 mm. wide, of last segment 1.6 mm. wide. Axis gently convex, articulating furrows deep. Pleurae of left side only preserved, width (transverse) of pleura of second segment 2.7 mm., of last segment 2.1 mm. Pleural furrow deep, straight, slightly diagonal, ending against broad facet. Tips of pleurae bluntly rounded.

Pygidium of length (sagittal) 2.7 mm., width measured over surface approximately 4.8 mm. Axis more than one-third total width, gently convex, the blunt tip not reaching the posterior margin. First three ring furrows distinct, fourth (situated just beyond half length) faint. Pleural lobe gently convex, no pleural furrows, divided at about half width by prominent longitudinal furrow which runs from the anterior margin sub-parallel to the lateral margin to abut against the tip of the axis. Narrow border behind tip of axis.

External surface of exoskeleton with reticulate pattern of fine, raised lines.

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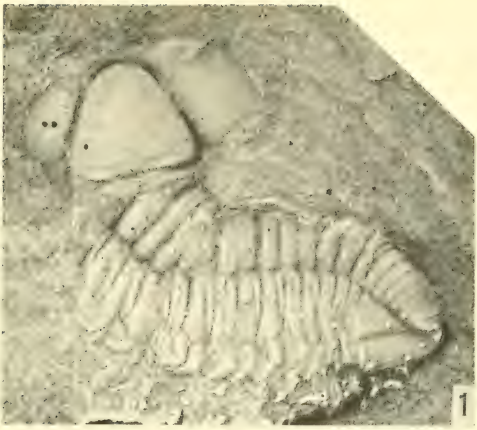

EXPLANATION OF PLATE 1

Colpocoryphe exsul sp. nov. x 6. U. S. Nat. Mus. Collections. Fig. 1. Rubber mould of holotype. The black spots on the left side of the cephalon are caused by minute holes in the mould. Fig. 2. Holotype, external mould.

BREVIORA

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CHARACTERS AND SYNONYMIES AMONG THE GENERA OF ANTS

Part II

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What follows is a continuation[1] of the inquiry into the characters and interrelationships among the genera of ants, having as its goal the eventual reclassification of the Formicidae along more natural and useful lines than those presently holding. Perhaps some readers will be surprised to find that several of the genera mentioned below were originally described in the wrong tribe or even in the wrong subfamily, and that many monotypic genera are actually synonymous with more familiar genera with which they have never been associated. Nevertheless, such cases are commonplace among the largely very artificial tribes of the larger subfamilies, and more of them will duly be exposed, and must be exposed, before the really basic work on ant classification can begin. A careful perusal of these cases, as well as those treated in Part I and in some of my other papers, will make clear the impossibility of constructing a workable key to the ant genera, and should also open the eyes of those who now regard the existing generic keys as basically sound. I think that I need not labor the fact that a key bringing what now prove to be synonymous genera out to different tribes is a key of very limited usefulness and is scarcely reliable. Only after the synonymy is fully uncovered, justified, and formally recorded can we begin to think of large-scale generic keys. It is suggested, therefore, that useful generic keys will be greatly hastened if more myrmecologists will spend a little of their time investigating and formally publishing new synonymy.

[1] Part I: Breviora, Mus. Comp. Zool. 11: 1–13 (1953).

Anochetus Mayr

Anochetus Mayr, 1861, Europ. Formicid., p. 53. Genotype: *Odontomachus ghiliani* Spinola, 1851, by designation of Bingham, 1903.

Myrmapatetes Wheeler, 1929, Amer. Mus. Novit., **349**: 6. Genotype: *Myrmapatetes filicornis* Wheeler, 1929, *loc. cit.*, fig. 3, male, monobasic. **New synonymy.**

Wheeler described *Myrmapatetes filicornis*, "obviously one of the Dolichoderinae," from a unique male taken on Larat Island, near New Guinea. His original figure, and even more clearly the type specimen in the Museum of Comparative Zoology, show that he had before him not a dolichoderine, but a ponerine male apparently representing one of the smaller Indo-Australian species of *Anochetus*, and typical of males of the latter genus in every respect save for its larger-than-usual compound eyes. When males and workers are associated in one nest series, further synonymy may result at the species level. Meanwhile, *Anochetus filicornis* (Wheeler) becomes the necessary **new combination.**

Asphinctopone Santschi

Asphinctopone Santschi, 1914, Boll. Lab. Zool. Portici, **8**: 318. Genotype: *Asphinctopone silvestrii* Santschi, 1914, *loc. cit.*, fig. 6, worker, monobasic.

Asphinctopone (*lucida*) Weber, 1949, Amer. Mus. Novit., 1398: 7, figs. 5–7, worker.

Lepidopone Bernard, 1953 (1952), Mém. Inst. Française Afr. Noire, **19** (1): 207. Genotype: *Lepidopone lamottei* Bernard, 1953, *op. cit.*, p. 208, fig. 4, worker, monobasic. **New synonymy.**

Professor Bernard has raised the genus *Lepidopone* for a species (*lamottei*) having the general characters of *Asphinctopone*, but supposedly differing in details of the coxae of the posterior legs, postpeduncle of the petiole and basiventral process of the gaster. However, it is difficult to understand how these features may be cited as differences marking a separate genus when none of them has as yet been reported upon for either species of *Asphinctopone*. From the descriptions and figures of *A. silvestrii* and *A. lucida*, it seems probable, not that the characters are absent, but rather that they are obscured by glue in the types or that they otherwise escaped observation. Bernard offers no further evidence concerning these structures of either older species, so it is premature to insist that their presence in the new species constitutes a valuable difference. The basiventral

process particularly should not be singled out as a diagnostic feature unless it is found to be developed in some unique direction; actually, this process in some form is found widely throughout the Ponerinae in many genera and species. However, even should the two *Asphinctopone* species prove, in the long run, to lack the unusual development of the characters in question as seen in *lamottei*, it would seem that the strong relationship of all three species named above overrides considerations based on minor characters. It seems preferable by far to avoid setting up what is at best a very weak monotypic genus when the generic unity of the three species is so clear. *Asphinctopone lamottei* (Bernard) becomes the necessary **new combination.**

Hylomyrma Forel

Pogonomyrmex (*Hylomyrma*) Forel, 1912, Mém. Soc. Ent. Belg., **20**: 16. Genotype: *Pogonomyrmex* (*Hylomyrma*) *columbicus* Forel, 1912, *loc. cit.*, by original designation.

Lundella Emery, 1915, Bull. Soc. Ent. France, p. 191. Genotype: *Tetramorium reitteri* Mayr, 1887, by original designation. **New synonymy.**

When Forel described *Hylomyrma*, he neglected to mention the spurs of the middle and posterior tibiae. By his association of the new group with *Pogonomyrmex*, the original author at least created the impression that the spurs were present and pectinate as in other members of the tribe Myrmicini. We still do not know whether pectinate spurs are present in Forel's two *Hylomyrma* species, but this question hardly matters now in the face of several exceptions to the same character in members of the Myrmicini. Forel also mentions as a character that "the labrum, with two lateral teeth, surpasses the anterior clypeal border." This is certainly incorrect; what Forel refers to here is the depressed anterior clypeal border which, in an indeterminate *Hylomyrma* specimen from Central America, has a low, blunt clypeal tooth on each side in such a position that a superficial examination might lead to the belief that they were on the labrum. This same indeterminate specimen has the spurs present and very minutely and sparingly barbulate as seen at great magnification. It seems evident from Forel's description of the mandibles and petiolar node, as well as other features, that *Hylomyrma* agrees well with Emery's *Lundella*, even though Emery assigned his genus to tribe Tetramoriini. *Lundella speciosa* Borgmeier, 1937, [described in Arch. Inst. Biol. Veg. 2: 241, figs. 25–29 (worker)] appears to me indis-

tinguishable from *Hylomyrma goeldii* Forel, if the descriptions concerned are accurate. Surely, *L. speciosa* is a typical *Hylomyrma*, and should be compared with authentic specimens of *H. goeldii*. Another specimen from Nova Teutonia, Santa Catharina (F. Plaumann), considered to be a *Lundella* near *reitteri* (Mayr) by Father Borgmeier, is also a *Hylomyrma*, and may be the same as *goeldii*, with the description of which it agrees. The recognition of the generic synonymy thus throws five species together and creates problems of specific synonymy that will only be certainly settled when more is known about the types concerned than is given in their mostly inadequate descriptions.

I believe that *Irogera*, considered by Emery to be a subgenus of *Rogeria*, is either very close to or synonymous with *Hylomyrma*. The two *Irogera* species from the New World, *I. procera* Emery and *I. tonduzi* (Forel), are known to me only from the original characterizations, which are very inadequate, and I therefore suspend judgment until the types can be examined. *Irogera* should, however, be considered as a genus distinct from *Rogeria* for the time being. Further it is clear that the Oriental-Pacific species placed by Mann in *Irogera*, and by Santschi in *Rogeria*, do not belong there, but instead should be shifted to *Lordomyrma* Emery. The further study of species belonging to the genera mentioned in this paragraph requires the review of certain crucial types before a solid rearrangement can be made. It is apparent now, however, that *Rogeria* has never been clearly defined, and that it has served as a dumping ground for ambiguous myrmicine species throughout its existence. While the species concerned are mostly rare and economically unimportant ones, little-known taxonomically or biologically, their systematic placement will affect myrmicine classification most profoundly.

Blepharidatta Wheeler (tribal transfer)

Blepharidatta Wheeler, 1915, Bull. Mus. Comp. Zool., **59**: 484. *Genotype: Blepharidatta brasiliensis* Wheeler, 1915, monobasic.

Wheeler and other authors have considered *Blepharidatta* to belong to tribe Attini or tribe Dacetini, but a recent study of the types of *B. brasiliensis* convinces me that the genus is really a member of the Ochetomyrmicini. The single species is very closely related to the species of *Wasmannia* Forel, differing chiefly in its more elongate head with produced posterior angles and in having a long, low petiolar node. *Wasmannia* seems scarcely to be separable from its sister-genus

Ochetomyrmex Mayr by means of the presently-employed character based on the form of the clypeus. *Wasmannia williamsoni* Kusnezov is one ambiguous species, and there may be still others in which the clypeal form is intermediate. I have already shown that *Hercynia* J. Enzmann is a junior synonym of *Wasmannia* (Brown, 1948, Ent. News, 59: 102).

Technomyrmex Mayr

Technomyrmex Mayr, 1872, Ann. Mus. Civ. Stor. Nat. Genova, **2**: 147. *Genotype: Technomyrmex strenuus* Mayr, 1872, by designation of Bingham, 1903.

Aphantolepis Wheeler, 1930, Psyche, **37**: 44. Genotype: *Aphantolepis quadricolor* Wheeler, 1930, *loc. cit.*, fig. 2, worker, monobasic. **New synonymy.**

In his figure of *A. quadricolor,* Wheeler shows an ant agreeing in every respect with a *Technomyrmex* of group *sophiae* Forel, but with a small, clearly-drawn poison-ejecting conule at the tip of the gaster. This conule is characteristic of the subfamily Formicinae, and Wheeler assigned his new genus to this subfamily. The type worker of *A. quadricolor* has long since been dislodged from its point and lost, but two whole legs and other fragments remain stuck to the glue on the point. Placed beside the type pin in Wheeler's collection are other specimens, determined as this species by Clark and evidently confirmed by Wheeler, collected by T. Greaves at Cairns, northern Queensland (the type locality is "Cairns dist., rotting leaves; A. M. Lea"). These specimens agree in detail with Wheeler's characterization and figures, and their legs correspond with the parts on the type point, but they do not have an ejaculatory conule. I myself took a specimen of this ant among dead leaves on the rain-forest floor at Kuranda, near Cairns (probably the precise locality of the original type collection), and this agrees perfectly with the other material. It is obvious that the ant in question is a dolichoderine, not a formicine, and that it is most closely related to *Technomyrmex sophiae* Forel of southern Queensland; Wheeler's depiction of the gastric apex is due to an illusion or an artifact that led him to think the conule was present in the type; he was probably further misled by certain large paired setae on the alitruncal dorsum that resemble those of *Paratrechina,* etc. The necessary **new combination** is *Technomyrmex quadricolor* (Wheeler); the ant is distinguished from other *Technomyrmex* species by its rounded propodeum and its rather smooth,

shining integument; it is ferrugineous yellow in color, with blackish gaster, whereas *T. sophiae* is black throughout.

Euprenolepis Emery

Prenolepis (*Euprenolepis*) Emery, 1906, Ann. Soc. Ent. Belg., **50**: 134. *Genotype: Prenolepis procera* Emery, 1901, by original designation.

Paratrechina (*Euprenolepis*) Emery, 1925, Gen. Ins., **183**: 223–224; synonymy and characterization.

Chapmanella Wheeler, 1930, Psyche, **37**: 41. *Genotype: Chapmanella negrosensis* Wheeler, 1930, *op. cit.*, pp. 42–44, fig. 1; worker (minor), monobasic. **New synonymy.**

Wheeler described his new genus and species from a single badly mauled worker taken from the column of a raiding *Aenictus* army. He differentiated his genus from *Prenolepis* and *Paratrechina* (*sensu* Emery in Gen. Ins.) by means of its small eyes, short palpi, form of petiole and gastric base, very long appendages, and the absence of spurs on the middle and hind tibiae. He was wrong about the last character; the type possesses minute spurs, one to each of the two posterior pairs of tibiae. The "apparently 6-jointed" maxillary palpi, shown with five segments in the original figure, are four-segmented in the type, with the basal and apical segments short and the second and third long. In these and other characters of habitus, eye size, etc., *C. negrosensis* shows itself to be a minor worker of one of the light-colored species of *Euprenolepis*, and it agrees well with a *Euprenolepis* species (undetermined) seen from New Guinea and Cape York, except that it has a somewhat thicker, lower petiolar node. *Euprenolepis negrosensis* (Wheeler) is the **new combination.**

Euprenolepis may as well be considered as an independent genus for the time being, though further investigation may show that it is connected to *Paratrechina* by intergrades. The workers are larger than most *Paratrechina-Nylanderia* species, and are, so far as is known, markedly polymorphic; the appendages are very long and slender, and like the rest of the body are set with numerous long, fine, erect hairs. The species vary in pigmentation, eye size, and shape of the petiole, but are otherwise rather homogeneous. In cabinet specimens, the mandibles are frequently closed so tightly as to cross over one another and lie largely hidden beneath the clypeus; this is seen in certain other formicine and dolichoderine genera on occasion.

The species *gevi* Wheeler apparently does not belong to *Euprenolepis*

lepis, as Wheeler believed; by its habitus, it is more like *Prenolepis*, and should be shifted to that genus pending revision of the whole complex. I have taken *geei* in moist deciduous forest at 4000 feet in the mountains behind Kuanhsien, Szechuan Province, West China; its type locality is Mokanshan, China.

Anisopheidole froggatti (Forel)

Pheidole froggatti Forel, 1902, Rev. Suisse Zool., **10**: 414, female, male.
Monomorium lippulum Wheeler, 1927, Boll. Lab. Zool. Portici, **20**: 89–90, fig. 3, worker (minor). **New synonymy.**

A. froggatti has a very broad range of polymorphic workers, although the largest soldier forms have so far only been reported in flourishing nests from extreme southwestern Australia. The distribution of this species is broader than commonly believed, and it occurs widely in central Australia and as far to the southeast as the Victorian Mallee. Cotypes of *M. lippulum* from the MacDonnell Ranges in central Australia (J. W. Finlayson) agree perfectly with an *A. froggatti* ergatotype and other specimens, all minor workers, from South and Western Australia. Localities for collections in the Museum of Comparative Zoology are as follows: Western Australia: Lion Mill ergatotype minim (Hamburg Expedition). Manjimup; Augusta (W. S. Brooks). Beverly (F. H. du Boulay). Wooroolоo, on Darling R.; Latham (L. Glauert). Rottnest I. (P. J. Darlington). Ludlow (J. Clark). Kukerin (A. Douglas). Margaret River (W. M. Wheeler). South Australia: Mt. Remarkable, Southern Flinders Ranges, ca. 1300 feet, under rock in dry open eucalypt woodland (W. L. Brown). Cape Borda Lighthouse, Kangaroo Island, under stone in low headlands sand heath (Brown). Victoria: Sea Lake, mallee district (J. C. Goudie). Northern Territory, in addition to *M. lippulum* type collection: 3–5 miles west and southwest of Alice Springs, depauperate colonies under stones in dry gullies, mulga (*Acacia aneura*) dominating vegetation (Brown). Other *M. lippulum* cotypes, in the South Australian Museum, are from Port Lincoln, South Australia, collected by A. M. Lea.

Anisopheidole Forel forms with its curious monotypic sister genera *Adlerzia* Forel and *Machomyrma* Forel a closely interrelated group showing certain features in common with *Pheidole* and *Stenamma*. The ranges of the single species of each of the three genera are largely separate so far as known; *Adlerzia froggatti* occupies southeastern

Australia, while *Machomyrma dispar* occurs in tropical and subtropical Queensland. When the sexual forms of these three species have been thoroughly compared, it may prove advisable to combine them into one genus in spite of notable differences in the form of the clypeus and petiole now serving to separate them generically.

The elimination of *lippulum* and *Adlerzia froggatti* from *Monomorium* helps considerably to relieve the heterogeneity of this large and taxonomically confused genus. Kusnezov has eliminated the South American group *Martia* Forel from consideration under *Monomorium* in a recent paper. It is by such small but necessary revisionary steps as these that confusion in the Myrmicinae will finally be eliminated.

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LOWER CRETACEOUS NAUTILOIDS FROM TEXAS

BY BERNHARD KUMMEL

INTRODUCTION

Nautiloids from the Lower Cretaceous of north central Texas are very limited in numbers of species and individuals. A recent paper by Miller and Harris (1945) on North American Cymatoceratidae noted only three species of nautiloids from the Washita group of north central Texas. These are *Cymatoceras hilli* (Shattuck), *Cymatoceras loeblichi* Miller and Harris, and *Paracymatoceras texanum* (Shumard). The present study is based on 13 specimens of immature nautiloids of the "pyrite faunae" of the Duck Creek, Pawpaw, and Grayson formations, plus three specimens of "calcareous" preservation from the Pawpaw formation. To the best of my knowledge this is the first description of nautiloids of the "pyrite faunae" from the Washita group. Adkins (1923, p. 57) records *Nautilus* sp. in his faunal list of the pyrite fauna from the upper Grayson formation, 4.5 miles south of McGregor, McLennan County, Texas. The pyrite fauna of the Pawpaw formation has been described by Adkins (1918) but he listed no nautiloids, and Böse (1927) has described numerous species of pyritized ammonites from the Grayson formation of north central Texas. Pyrite faunae are known from the Duck Creek, Denton, Pawpaw, and Grayson formations of the Washita group in north central Texas.

The pyritized nautiloids are all juvenile specimens of approximately one volution. They are tentatively placed in *Cymatoceras* and *Paracymatoceras* largely because they are associated with large mature species of these two genera. One of the specimens of calcareous preservation from the Pawpaw formation belongs in the genus *Angulithes*. This is the first reported occurrence of this genus in North America. There are recognized at the present 15 genera of nautiloids in the

Cretaceous. In all of the Cretaceous formations of North America only five genera of nautiloids are known, *Cymatoceras, Paracymatoceras, Eutrephoceras, Heminautilus,* and *Angulithes.*

The pyrite faunae of the Washita group have been considered as dwarfed by various authors (Scott, 1924, 1940, Winton, 1925). The question of dwarfism of these faunae has also been discussed by Kummel (1948). The nautiloids described here are juvenile individuals and are not dwarfed forms.

The author expresses his thanks to Dr. J. T. Lonsdale, Director of the Bureau of Economic Geology, Austin, Texas, for the loan of the specimens and permission to publish this note. The Department of Geology, University of Illinois, furnished the photographic equipment and facilities to complete the study for which the author is grateful. Throughout the report the Bureau of Economic Geology is abbreviated as B.E.G.

SYSTEMATIC DESCRIPTIONS

Cymatoceras sp. indet.

Plate 1, figures 1–12; plate 2, figures 1–3

Eleven small immature specimens are available for study. The smallest specimen measures 12 mm. in diameter and the largest 21 mm. All of the specimens include approximately one volution of the conch, they are septate throughout, and no living chambers are preserved. In all of them the conch is nautiliconic, the whorl section is higher than wide, and the venter is rounded. In some of the specimens, portions of the venter are more sharply rounded. The number of camerae present ranges from 6 to 8. The most adoral sutures are strongly projected adorally forming a rounded ventral saddle, a broad concave lateral lobe and a small rounded saddle on the umbilical shoulder. The first suture is essentially straight; however, the second suture already shows distinctly the ventral saddle and the lateral lobe. A small annular lobe is present in the middle of the dorsal lobe (pl. 2, fig. 3). The siphuncle is small, rounded, and located very near the dorsum. All the specimens are internal molds and have no surface markings of any kind.

Small immature nautiloids are usually impossible to identify specifically and very difficult to determine generically. All the specimens studied came from the Duck Creek, Pawpaw, and Grayson formations and are part of the characteristic pyrite faunae of these formations.

There are also mature and relatively large specimens of calcareous preservation of *Cymatoceras hilli*, *Paracymatoceras texanum*, and *Paracymatoceras* sp. indet. Hyatt (1894) described and figured juvenile specimens of *Cymatoceras elegans?* (*Paracymatoceras texanum*), *C. deslongchampsianus*, *C. simplex?*, *C. radiatum*. The simple outline figures by Hyatt of the early whorls of the above species compare very favorably with the specimens figured here. The degree of involution, ontogeny of the suture, and shape of the cross section are quite similar. The writer has also compared his material with specimens of approximately the same size of various species of *Cymatoceras* from the Gault of England in the British Museum of Natural History.

Branco (1880) figured the first and second camerae of *Nautilus clementinus* d'Orbigny (=*Cymatoceras*) For *Nautilus* cf. *deslongchampsianus* d'Orbigny (=*Cymatoceras*) he figured the first four septa. The first two septa are essentially straight. The third septum shows a well developed ventral saddle with only a very shallow lateral lobe. The fourth septum has an even more pronounced ventral saddle and a wide lateral lobe. This fourth septum is very similar to the septa of the specimens of *Cymatoceras* described here.

Durham (1946, p. 432, pl. 63, figs. 3, 5, 7) described and figured a juvenile specimen of *Hemiauutilus etheringtoni* from the upper Aptian of Colombia. This specimen includes approximately one volution and measures 6 mm. in diameter. The whorl section is subtrigonal. The venter is slightly flattened and with a faint groove. This specimen with its subtrigonal outline compares favorably with those of *Cymatoceras* sp. figured on plate 1, figures 10–12.

Nautiloids in the Cretaceous of Texas are not abundant and representatives of only four genera, namely *Cymatoceras*, *Paracymatoceras*, *Eutrephoceras*, and *Angulithes* are known. In the Washita group *Cymatoceras* and *Paracymatoceras* have been known for a long time. The small immature specimens described here probably belong in *Cymatoceras*. Juvenile specimens of *Paracymatoceras* of comparable size already have very sinuous sutures. The adorally projecting suture could possibly develop into the sinuated suture of *Paracymatoceras* in more advanced ontogenetic stages. In respect to these two genera Miller and Harris (1945, p. 10) state that, "Presumably these two genera will be found to grade more or less into each other." When a more complete ontogenetic series of specimens can be assembled there should be no difficulty in determining the proper affinities of these specimens.

Occurrence. (1) Duck Creek formation, cut along Frisco R.R. about one mile north of Denison, Texas; (2) Pawpaw formation, halfway between Glen Garden Country Club and Sycamore Creek, 3 miles southeast of Fort Worth, Tarrant County (locality 723 of Adkins, 1918, p. 51); (3) Grayson formation, 4.5 miles south of McGregor and 100 yards east of the highway, McLennan County (locality 966 of Adkins, 1923, p. 52); 1½ miles south of Bosqueville on the Belmont place, McLennan County; and at Bosqueville, McLennan County.

Repository. B.E.G. 297 (pl. 1, figs. 7–9), 3057 (pl. 1, figs. 4–6), 3002 (pl. 1, figs. 10–12; pl. 2, figs. 1, 2), 18750 (pl. 1, figs. 1–3), 3273 (pl. 2, fig. 3).

Cymatoceras hilli (Shattuck)

This species has recently been described and figured by Miller and Harris (1945) and the description need not be repeated here. Two specimens from the Pawpaw formation are available. They are well preserved internal molds 70 mm. and 65 mm. in diameter, and have no surface markings of any kind.

Occurrence. Pawpaw formation, at Blue Mound, 2 miles southwest of Haslet, Tarrant County, B.E.G. loc. 219-T-1; and along east side of Mansfield Road, halfway between Glen Garden Country Club and Sycamore Creek, 3 miles southeast of Fort Worth, Tarrant County, B.E.G. loc. 219-T-17 (locality 723 of Adkins, 1918, p. 51).

Repository. B.E.G. 17414.

Paracymatoceras sp. indet. 1
Plate 2, figures 6–7

A unique specimen forms the basis of this discussion. It measures 46 mm. in diameter, is partially crushed, septate throughout, and has the shell preserved. The conch is involute, compressed, and essentially smooth. The venter is broadly rounded, ventral shoulders distinct and rounded. The flanks are broadly convex and converge towards the venter. The maximum width of the whorl is just ventral of the umbilical shoulder. The umbilical shoulder is broadly rounded and the umbilical wall slightly convex, sloping at an angle toward the umbilicus which has the shape of a broad open funnel. The suture forms a broad rounded ventral saddle, a deep lateral lobe of approximately the same width as the ventral saddle, and a second smaller saddle on the umbilical wall. The siphuncle is not observable. The

surface of the shell has very faint ribs that are slightly sigmoidal on the flanks and form a deep sinus on the venter. The specimen is slightly crushed and several of the cracks in the shell follow along the line of the ribbing. The ribbing is at most very faint but is most distinct at the adoral part of the specimen.

Paracymatoceras differs from *Cymatoceras* only in the greater sinuosity of the suture. Miller and Harris (1945) suggest that these two genera may be gradational. Only one species of *Paracymatoceras*, namely *P. texanum* (Shumard), has been recorded from North America. That species is not uncommon in the Washita group of Texas. *Paracymatoceras* sp. indet. 1, differs from *P. texanum* primarily in its very subdued ribbing. It is undoubtedly an immature specimen which makes direct comparison difficult. Most of the specimens of *P. texanum* that have been collected in the Washita group of north Texas are internal molds of argillaceous limestone and few of the specimens have the shell preserved.

Spath (1927) and Miller and Harris (1945) have pointed out that the ribbing in the Cymatoceratidae can be very subdued. The suture of *Paracymatoceras* is very similar to that of *Hercoglossa* of the late Cretaceous and early Cenozoic. *Pseudaganides* is a late Jurassic genus also with a hercoglossid suture. In the Upper Triassic the Clydonautilidae are characterized by very sinuous sutures. Each of these nautiloid groups with sinuous sutures are probably independent developments and are not genetically related.

There are only five species of late Jurassic and Cretaceous nautiloids that can be placed in *Paracymatoceras* at this time; these are: *P. asper* (Oppel), the type species from Tithonian formations of Europe, *P. trichinopolitensis* (Blanford) from the Ariyalur group (Senonian) and *P. rota* (Blanford) from the Uttattur group (Albian) of south India, *P. texanum* (Shumard) from the Washita group of Texas, and *P.* sp. indet. 1, from the Pawpaw formation of Texas. The south Indian Cretaceous nautiloid fauna described by Blanford and Stoliczka (1861–66) and Spengler (1910) contains numerous cymatoceratids and also some species of *Hercoglossa*. As more Cretaceous nautiloids are discovered it will become increasingly difficult to differentiate those essentially smooth or weakly ribbed species of *Paracymatoceras* from *Hercoglossa*.

Occurrence. Pawpaw formation, from a pit of the Cobb brick yard, $\frac{1}{4}$ mile east of Sycamore Creek and 3 miles southeast of Fort Worth, Tarrant County (locality 716 of Adkins, 1918, p. 47).

Repository. B.E.G. 196 (pl. 2, figs. 6, 7).

PARACYMATOCERAS sp. indet. 2
Plate 2, figures 8–10; text figure 1

One small, immature specimen measuring 28 mm. in diameter warrants separate discussion. The specimen is a smooth internal mold preserved in the typical manner of the pyrite fauna of the Pawpaw formation. It is very involute, compressed, and with a well rounded venter. The suture forms a broadly rounded ventral saddle, and a deep lateral lobe followed by a smaller saddle. The siphuncle was not observed.

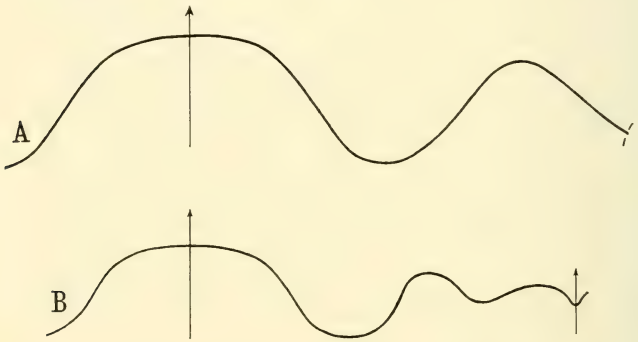

Figure 1. Diagrammatic representation of sutures. A, *Paracymatoceras* sp. indet. 2, at a diameter of about 24 mm., X 4; B, *Paracymatoceras* sp. indet. 3, at a whorl height of 6 mm., X 7.

I was at first inclined to place this specimen in *Hercoglossa* because it is perfectly smooth and has a typical hercoglossid suture, but possible pre-Danian Cretaceous species of *Hercoglossa* are known only from south India, and since *Paracymatoceras* sp. indet. 2 is associated with *P.* sp. indet. 1 and *P. texanum*, it is highly probable that *P.* sp. indet. 2 is a juvenile smooth specimen of *Paracymatoceras*. Very little is known of the ontogenetic development of ribbing in *Paracymatoceras*. The possibility exists, however, of this specimen being a juvenile *Hercoglossa*.

Loesch (1914) has described numerous species of Upper Jurassic nautiloids with very sinuous sutures. He includes figures of juvenile

specimens for *Nautilus schneidi* (pl. 1, fig. 5a, b, c), *N. ammoni* (pl. 3, figs. 5a, b, c), *N. strambergensis* (pl. 5, figs. 6a, b), and *N.* sp. (pl. 6, figs. 6a, b, c). In these four species of Upper Jurassic hercoglossids the sinuosity of the suture is very pronounced by the end of the first quarter whorl. On the mature whorls of these species the ventral saddle has a shallow lobe, likewise the ventral shoulders generally become angular. The specimen from the Pawpaw formation figured here is very similar to specimens of comparable size figured by Loesch (1914) of *Nautilus schneidi* (pl. 1, fig. 5c) and *N. ammoni* (pl. 3, figs. 4a, b).

Occurrence. Pawpaw formation, one-fourth mile south of the International and Great Northern railway bridge across Sycamore Creek, 4½ miles southeast of Fort Worth, Tarrant County, B.E.G. loc. 219-T-23.

Repository. B.E.G. 17425 (pl. 2, figs. 8–10).

Paracymatoceras sp. indet. 3

Plate 2, figures 4, 5; text figure 1

One small internal mold consisting of only two and one-half camerae is sufficiently distinct to be kept separate from the other specimens of *Paracymatoceras* described here. The specimen is from the pyrite fauna of the Pawpaw formation. The whorls measure 6 mm. in height and 8 mm. in width. The venter is broadly rounded, flanks convex, and the umbilical shoulders are sharply rounded. The suture has a broad ventral saddle and a deep rounded lateral lobe followed by a smaller saddle. There is a small annular lobe in the middle of the dorsal lobe. The small siphuncle is slightly dorsad of the center of the whorl. The internal mold is perfectly smooth.

This specimen differs from the other specimens of *Paracymatoceras* in having a more subquadrate outline. As with *P.* sp. indet. 2, this fragmentary specimen is thought to be a portion of a juvenile individual. Whether or not it is conspecific with the other two specimens of *Paracymatoceras* described above cannot be told. The general proportions of *P.* sp. indet. 3, are so different that they do not suggest specific identity.

Occurrence. Pawpaw formation, at headwaters of Buffalo Creek, 0.5 miles southeast of Blue Mound and 2.2 miles south of Haslet, Tarrant County, B.E.G. 219-T-2.

Repository. B.E.G. 17415 (pl. 2, figs. 4, 5).

ANGULITHES sp. indet.
Text figure 2

This is the first representative of this genus recorded from North America. The specimen is a somewhat weathered internal mold of five camerae and a portion of the living chamber. The flanks are moderately convex and strongly converge to a narrowly rounded venter. The greatest width of the whorl is just ventrad of the broadly rounded umbilical shoulder. The suture forms a narrowly rounded ventral saddle, a broad shallow lateral lobe which occupies the whole flank, and a small low saddle on the umbilical wall. The siphuncle is 3.5 mm. in diameter and located rather close to the dorsum.

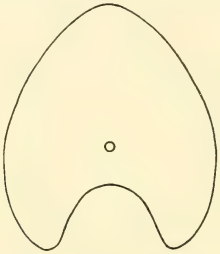

Figure 2. Diagrammatic cross section of *Angulithes* sp. indet., X 1.

The genus *Angulithes* Montfort (type species *Nautilites triangularis* Montfort) is characterized by a tightly coiled conch, strongly convergent flanks and a venter that is angular or narrowly rounded. Foord and Crick (1890, p. 404) point out that the venter on *A. triangularis* is alternately rounded and sharply angular. There are only five species of Cretaceous nautiloids that appear to belong in the genus *Angulithes*; these are *A. triangularis*, the type species, from Cenomanian formations of France and England; *A. tamulicus* (Kossmat) from the Danian of south India; *A. westphalicus* (Schluter) from the lower Senonian of Germany; *A. fleuriausianus* (d'Orbigny) from the Cenomanian of England and Europe; and *A.* sp. indet. from the Pawpaw formation of Texas. Due to the fragmentary nature of the specimen at hand direct comparison with the other species of this genus is difficult. It is most similar in general outline to the type species and to *A. fleuriausianus*. The specimen is too poorly preserved

to warrant a specific name but the record of a species of the genus *Angulithes* in North America is of interest.

Deltoidonautilus — type species *Nautilus sowerbyi* Wetherell — was proposed by Spath (1927) for Eocene nautiloids with nautiliconic conchs and more or less sagitate cross sections with narrowly rounded to angular ventral zones. The sutures form narrowly rounded ventral saddles, rounded lateral lobes, and a small saddle near the umbilical wall. The siphuncle is located near the dorsum. Spath pointed out the similarity of whorl shape of *Deltoidonautilus* to *Angulithes*; however, he thought that *Angulithes* " . . . with its less sinuous suture-line was more closely allied, via *Ang. fleuriausianus* (d'Orbigny) with the regular Nautiloid stock that produced *Pseudocenoceras* in the Cretaceous, as it had given rise before to the less specialized *Paracenoceras* of the *calloviensis* type."

Examination of the various species of *Angulithes* from the European Cretaceous and the specimen from the Pawpaw formation described here shows no appreciable differences between *Deltoidonautilus* and *Angulithes*. At the time Spath proposed the genus *Deltoidonautilus* it was known only from the Eocene. The range of *Deltoidonautilus* is now known to be Paleocene to Oligocene (Miller, 1951). The few species of *Angulithes* range well throughout the Cretaceous. Because of the similarity of *Deltoidonautilus* and *Angulithes* the genus *Deltoidonautilus* should be suppressed and its species placed in the genus *Angulithes* which has priority.

Occurrence. Pawpaw formation, at hillside on north side of east-west road, 3 miles southeast of Haslet, Tarrant County, B.E.G. loc. 219-T-8 (locality 724 of Adkins, 1918, p. 51).

Repository. B.E.G. 17421.

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EXPLANATION OF PLATE 1

Figs. 1–12. *Cymatoceras* sp. indet. all figures X2. 1–3, B.E.G. 18750, from Grayson formation, 4.5 miles south of McGregor, McLennan County, Texas. 4–6, B.E.G. 3057, Grayson formation, 1.5 miles south of Bosqueville, McLennan County, Texas. 7–9, B.E.G. 297, Duck Creek formation, one mile north of Denison, Texas. 10–12, B.E.G. 3002, Grayson formation, Bosqueville, McLennan County, Texas.

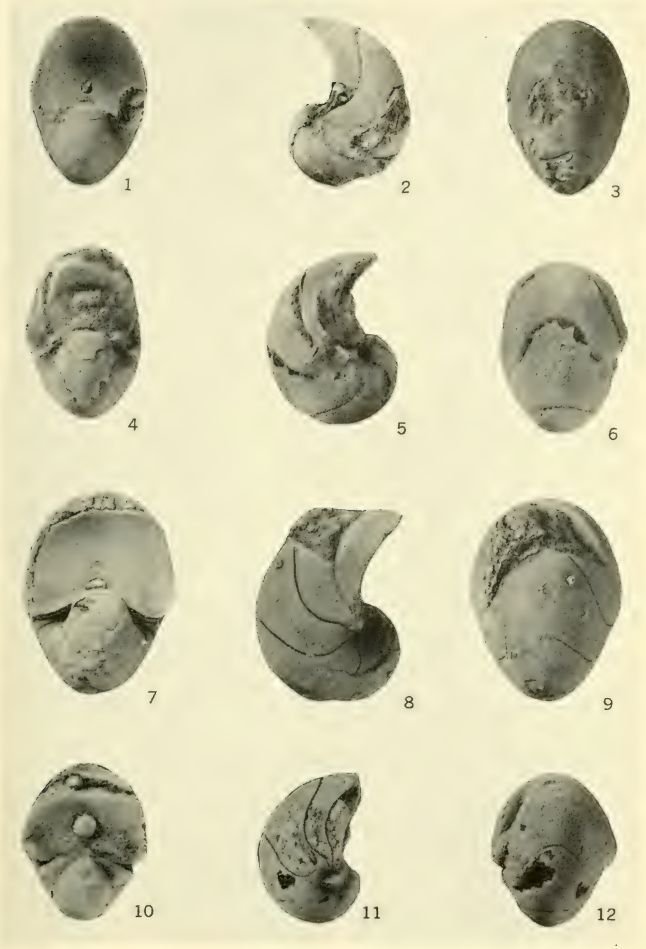

PLATE 1

EXPLANATION OF PLATE 2

Figs. 1–3. *Cymatoceras* sp. indet. 1, 2, B.E.G. 3002, Grayson formation, Bosqueville, McLennan County, Texas, X2. 3, B.E.G. 3273, front view of camerae showing annular lobe and siphuncle, Grayson formation midway between McGregor and Moody, Texas, X2.

Figs. 4–5. *Paracymatoceras* sp. indet. 3, B.E.G. 17415, 2 views of a specimen from the Pawpaw formation, 2.2 miles south of Haslet, Tarrant County, Texas, X2.

Figs. 6–7. *Paracymatoceras* sp. indet. 1, B.E.G. 196, 2 views of a specimen from the Pawpaw formation, 3 miles southeast of Fort Worth, Texas, X1.

Figs. 8–10. *Paracymatoceras* sp. indet. 2, B.E.G. 17425, 3 views of a specimen from the Pawpaw formation, 4.5 miles southeast of Fort Worth, Texas, X1.

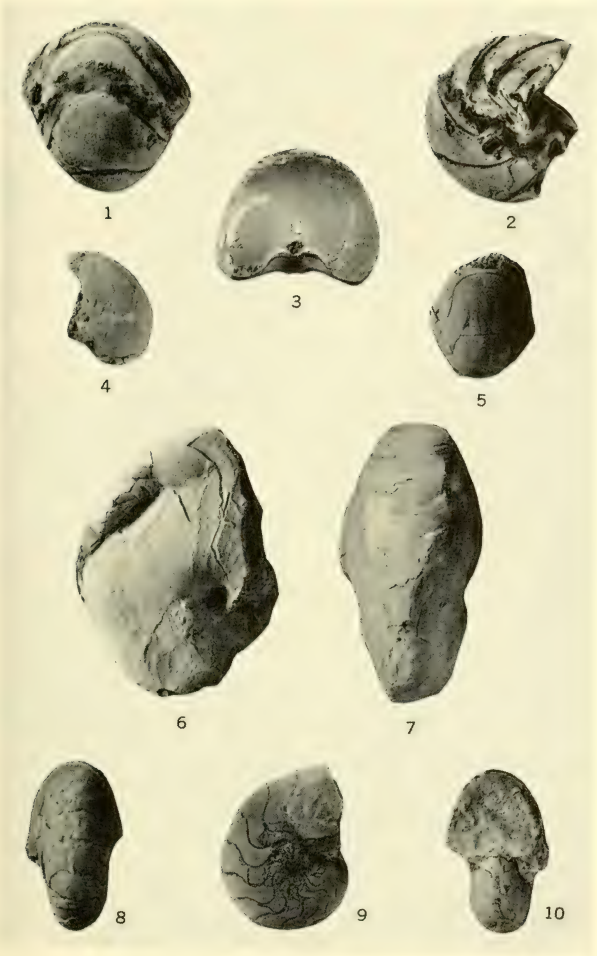

PLATE 2

BREVIORA

Museum of Comparative Zoology

CAMBRIDGE, MASS. SEPTEMBER 23, 1953 NUMBER 20

LOWER TRIASSIC SALT RANGE NAUTILOIDS

BY BERNHARD KUMMEL

INTRODUCTION

Triassic nautiloids in contrast to the ammonoids are not abundant in the fossil record nor are they very diverse in kinds. A monograph in press by the writer on late Paleozoic and Triassic nautiloids demonstrates that the evolutionary pattern of Triassic nautiloids is merely a culmination of trends that started in the Carboniferous. There is no marked change in nautiloid evolution at the Permo-Triassic boundary. In contrast to this pattern the ammonoids suffered severe extinction in the Permian, and in the early Triassic went through an "eruptive" development of numerous new stocks. For both the ammonoids and the nautiloids the Triassic-Jurassic boundary was a period of greater crisis. Only one stock of ammonoids survived to give rise to the great host of forms known in the Jurassic and Cretaceous. The nautiloids likewise became nearly extinct at the end of the Triassic but a stock probably out of the Syringonautilidae led to a new but more modest radiation of the group.

Of the approximately 250 species of Triassic nautiloids in 30 genera, 17 are from the Scythian, 74 from the Anisian, 28 from the Ladinian, 90 from the Carnian, 39 from the Norian, and none is certain from the Rhaetian. The Lower Triassic or Scythian species are the only ones that will be mentioned here. These Lower Triassic nautiloids include: *Metacoceras* (*Mojsvaroceras*) *subaratum* (Keyserling) 1860, from northern Siberia; *Pleuronautilus dieneri* Krafft and Diener, 1909, *Grypoceras* (*Grypoceras*) *brahmanicum* (Griesbach) 1880, *Grypoceras* (*Grypoceras*) *hexagonalis* Diener, 1897, *Grypoceras* (*Grypoceras*) *lilangense* Krafft and Diener, 1909, from the Himalayas; *Pleuronautilus subquadrangulus* Tien, 1933, from south China; *Pleuronautilus kokeni* Frech, 1905, *Tainionautilus trachyceras* Frech, 1905, *Menuthionautilus kieslingeri* Collignon, 1933, *Grypoceras* (*Grypoceras*) *bidorsatoides* n. sp.,

Grypoceras (*Grypoceras*) *aemulans* n. sp. from the Salt Range, Pakistan. *Menuthionautilus kieslingeri* was originally described from Scythian strata of northern Madagascar (Collignon, 1933). The Lower Triassic Dinwoody and Thaynes formations of Idaho have yielded new species of *Mojsvaroceras*, *Pleuronautilus*, *Enoploceras*, *Germanonautilus*, and *Grypoceras*. The descriptions of these new species are in press (Kummel, 1953). Muller and Ferguson (1939) list *Grypoceras* cf. *brahmanicum* (Griesbach) from the Candelaria formation of Nevada.

In the Lethaea Geognostica (Frech, 1903–1908), in the chapter on the Asiastic Trias (written by Fritz Noetling), there are described two species of nautiloids from the Lower Triassic of the Salt Range. These are *Tainionautilus trachyceras* from the Ceratite Sandstone (zone of *Flemingites flemingianus*) and *Pleuronautilus kokeni* from the Upper Ceratite Marls (zone of *Koninckites volutus*). The chapter on the faunal characteristics of the Salt Range Lower Triassic formations states that there are 5 to 6 species of nautiloids of which 4 to 5 species are undescribed (Frech, 1903 1908, pp. 167–168). These undiagnosed specimens of nautiloids from the Lower Triassic formations of the Salt Range are in the British Museum of Natural History as part of the Koken Collection and are described here. Besides the three species described below, there are two specimens of *Pleuronautilus* (B.M.N.H. C10429 and C10426) from the Ceratite Marls, Chideru, Salt Range, to which Koken had applied manuscript names but they are too poorly preserved to warrant description.

The writer is pleased to acknowledge the kind hospitality of Dr. W. N. Edwards, Keeper of Geology of the British Museum, and Dr. L. F. Spath, and their permission to study these specimens. The photographs were taken at the British Museum by its staff photographer.

SYSTEMATIC DESCRIPTIONS

Family GRYPOCERATIDAE Hyatt, 1900

Genus GRYPOCERAS Hyatt, 1883

Type species. Nautilus mesodicum Hauer, 1846.

There are approximately 22 species of Upper Paleozoic nautiloids assigned to *Domatoceras* (type species, *Domatoceras umbilicatum* Hyatt, 1891). They are characterized by being flattened ventrally and laterally and slightly impressed dorsally. The sutures form rounded

ventral, lateral, and dorsal lobes. The siphuncle is subcentral in position and orthochoanitic. Species of *Domatoceras* show much variation in the degree of involution and in the position of the siphuncle.

The Triassic genus *Grypoceras* has long been recognized as very similar to late Paleozoic domatoceratids (Mojsisovics 1902, p. 227). *Grypoceras* differs from *Domatoceras* in generally being more involute, the ventral area more rounded, the lobes more concave, and in having an annular lobe. The Lower Triassic grypoceratids are especially similar to typical domatoceratids. The degree of involution of 12 species of *Domatoceras* shows the percentage of the diameter of the umbilicus to the diameter of the conch to range from 16 to 50. The two most involute species, *D. kleihegei* (17%) and *D. moorei* (16%), are transitional forms to *Stenopoceras*. The same data on 9 species of *Grypoceras* show a percentage range from 8.5 to 30. Species of both genera, likewise, show variability in the position of their siphuncle. The Lower Triassic species of *Grypoceras* have angular ventral shoulders, the Middle and Upper Triassic species generally have more rounded shoulders. These data suggest that *Grypoceras* is a direct evolutionary continuation of the late Paleozoic *Domatoceras*, and the two genera are gradational in most characters. The principal differences are in the presence of an annular lobe and the greater involution of *Grypoceras*. Under these circumstances full generic status for *Domatoceras* does not seem warranted and it is here placed as a subgenus of *Grypoceras* since the latter genus has priority.

Grypoceras is widely distributed geographically, being more or less common in the Alpine and Himalayan Triassic regions. It is also reported in Triassic rocks from North America, the Ussuri region, Timor, and New Zealand. Stratigraphically it is equally widespread. There are five species in the Scythian, eight in the Anisian, three in the Carnian, three in the Norian, and there is a form allied to *G. mesodicum* in the Rhaetic of Kossen (Mojsisovics, 1873, p. 22).

Grypoceras (Grypoceras) bidorsatoides (Koken MS) n. sp.

Plate 1, figures 1, 2

This species is based on one well preserved specimen of phragmocone and living chamber. It measures 55 mm. in diameter, 27 mm. in height of the last whorl, and 30 mm. in the width of the last whorl. The umbilicus is 8 mm. in diameter. The whorl section is subquadratic in outline. The flanks are flattened and converge toward the venter. The

venter is flattened on the phragmocone and becomes concave on the living chamber. The ventral shoulders are rounded and prominent. The umbilical shoulders are more broadly rounded and the umbilical wall is vertical. The shell is preserved on parts of the conch and is smooth except for faint lines of growth. The septa form a broad, shallow, ventral and lateral lobe. The siphuncle is in a subventral position, being only 4 mm. from the venter at a point where the whorl height is 22 mm.

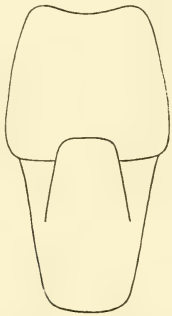

Fig. 1. Diagrammatic cross-section of *Grypoceras* (*Grypoceras*) *bidorsatoides* n. sp., X1.

Remarks. *G.* (*Grypoceras*) *bidorsatoides* is closely related to *G.* (*Grypoceras*) *brahmanicum* of the *Otoceras* beds of the Himalayas. The Salt Range species is more involute and more depressed in cross section. The siphuncle of *G.* (*Grypoceras*) *brahmanicum* is in a near ventral position in the early whorls but on the last whorl has a position closer to the center of the whorl. *G.* (*Grypoceras*) *lilangense* from the "*Meekoceras*" beds of the Himalayas has a very rapidly expanding and large conch, and no comparison can be made with *G.* (*Grypoceras*) *bidorsatoides*. The Dinwoody formation in Idaho has yielded a new species of *Grypoceras* that is somewhat similar to this Salt Range species but more compressed and with a high whorl section. Except for greater involution, *G.* (*Grypoceras*) *bidorsatoides* is similar to several species of upper Paleozoic domatoceratids.

Occurrence. Lower Ceratite Marl, zone of *Prionolobus rotundatus*, Chideru, Salt Range, Pakistan.

Repository. B.M.N.H. C10428, holotype.

GRYPOCERAS (GRYPOCERAS) AEMULANS (Koken MS) n. sp.
Plate 2, figure 4

Only one moderately well preserved specimen is available for study. It consists of a complete phragmocone and only a quarter volution of body chamber. The conch measures 60 mm. in diameter; the most adoral part of the last whorl measures 30 mm. in height and 27 mm. in width. The umbilicus is 10 mm. in diameter. The whorl sides are convex and converge toward the venter. The ventral shoulders are angular. The venter is broad and slightly arched. The umbilical shoulders are sharply rounded and the umbilical walls vertical. The suture forms a very shallow ventral lobe, and a broad sweeping lateral lobe. The position of the siphuncle is not known; it is not, however, in a near ventral position. No part of the shell is preserved.

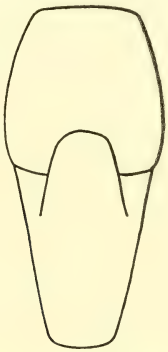

Fig. 2. Diagrammatic cross-section of *Grypoceras* (*Grypoceras*) *aemulans* n. sp., X1.

Remarks. *Grypoceras* (*Grypoceras*) *aemulans* differs from *G.* (*G.*) *bidorsatoides* in being more compressed and in having an arched venter, not concave on any part of the conch. *G.* (*G.*) *brahmanicum* is more evolute and with rounded ventral shoulders. *G.* (*G.*) *hexagonalis* differs also in its greater involution and in the shape of the whorl section. *G.* (*G.*) *aemulans* like *G.* (*G.*) *bidorsatoides* is similar to late Paleozoic domatoceratids except for the greater involution of the conch.

Occurrence. Lower Ceratite Marl, zone of *Prionolobus rotundatus,* Chideru, Salt Range, Pakistan.

Repository. B.M.N.H. C47068, holotype.

Genus MENUTHIONAUTILUS Collignon, 1933

Type species. Nautilus (Menuthionautilus) kieslingeri Collignon, 1933

MENUTHIONAUTILUS KIESLINGERI Collignon

Plate 1; figures 3, 4; plate 2, figures 1–3

Nautilus (Menuthionautilus) kieslingeri Collignon, 1933, Annales de Paleontologie, tome 22, pp. 164–166, pl. 1, figs. 1, 1a.

Four incomplete but well preserved specimens of this interesting species are available. The conch is involute, compressed, and smooth.

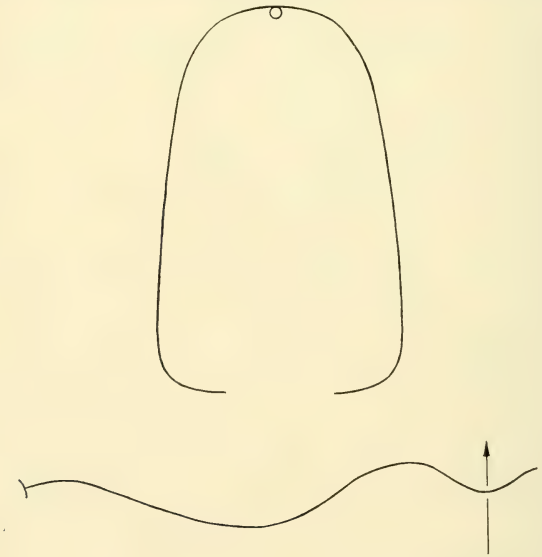

Fig. 3. Diagrammatic cross-section and representation of an external suture of *Menuthionautilus kieslingeri,* X1.

The whorls are much higher than wide. The largest specimen (pl. 2, fig. 1) has a whorl height of 67 mm. and a width of approximately 41 mm. The whorl sides are slightly convex and converge toward the venter. The ventral shoulders are well rounded and the venter broadly arched (text fig. 3).

The umbilicus is small in diameter. On the figured paratype (pl. 2, fig. 3), 40 mm. in diameter, the umbilicus measures 6 mm. The umbilical shoulders are abruptly rounded and the umbilical wall convex and vertical. The suture forms a shallow, acutely rounded ventral lobe, a broad, rather prominent lateral lobe which occupies the whole whorl side ending at an indistinct saddle on the umbilical wall. The siphuncle is in an extreme ventral position and in the largest specimen measures 2 mm. in diameter. The ventral position of the siphuncle is well illustrated in the immature specimen figured on Plate 1, figure 3.

Remarks. Collignon's specimen came from the Lower Triassic (Scythian) formation at Barabanja, Madagascar. The Salt Range specimens described and figured here are very similar in nearly all features to the type specimen from Madagascar. The Salt Range forms are the only other recorded specimens of this genus and species.

Collignon (1933) established *Menuthionautilus* as a subgenus of *Nautilus* and he recognized the uniqueness of this Triassic nautiloid with its ventral siphuncle. He compared his species with *Paranautilus* and *Grypoceras*. There appears to be little actual affinity with *Paranautilus*. The *Paranautilidae* are a stock that tended toward involute, globular conchs and simplified septa. There are very few compressed species of *Paranautilus*, *Indonautilus*, or *Sibyllonautilus*. The *Paranautilidae* stem from the upper Paleozoic *Liroceratidae* and themselves gave rise to the *Clydonautilidae* of the Upper Triassic with their very sinuous sutures.

The inner whorls of *Menuthionautilus* are more quadratic in cross section, having low arched venters and sharply rounded ventral shoulders. The characters of the conch of *Menuthionautilus* show clearly affinities to *Grypoceras* of the Triassic and *Grypoceras* (*Domatoceras*) of the Pennsylvanian and Permian. The Grypoceratidae include the following genera: *Grypoceras*, *Grypoceras* (*Domatoceras*), *Stenopoceras*, *Stearoceras*, *Titanoceras*, *Menuthionautilus*, and *Gryponautilus*. The evolutionary patterns in this family show three main trends: (a) towards involution, (b) towards rounding of the ventral shoulders, and (c) towards greater sinuosity of the suture. At the same time there is great variability in the position of the siphuncle among the

various species. In an analysis of 10 species of *G.* (*Domatoceras*) the percentage of the distance from the venter to the siphuncle, to the height of the whorl varied from 12.5 to 50. The same measurements for species of *Grypoceras* range from 30 to 50 per cent. As mentioned above under the discussion of *Grypoceras* and *G.* (*Domatoceras*) these two forms are believed to belong to a continuous evolutionary series. *Menuthionautilus* is most likely a development out of this *Domatoceras-Grypoceras* line. The similarity of the whorl section, general plan of the suture, and known variability of the siphuncle in the parent stock strongly support this relationship.

Occurrence. Lower Ceratite Marl, zone of *Prionolobus rotundatus*, Chideru, Salt Range, Pakistan.

Repository. B.M.N.H. C10433 (pl. 2, fig. 1), C10438a (pl. 1, figs. 3, 4), C10438b (pl. 2, fig. 3), C10438c (pl. 2, fig. 2).

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EXPLANATION OF PLATE I

The specimens illustrated on this plate are from the Lower Ceratite Marl, zone of *Prionolubus rotundatus*, Chideru, Salt Range, Pakistan. They are deposited in the British Museum of Natural History, London. All figures X 1.

Figs. 1, 2. *Grypoceras* (*Grypoceras*) *bidorsatoides* n. sp., B.M.N.H. — C10428, holotype.

Figs. 3, 4. *Menuthionautilus kieslingeri* Collignon. Immature specimen; figure 3 shows clearly the ventral position of the siphuncle. B.M.N.H. — C10438a, paratype.

PLATE 1

EXPLANATION OF PLATE 2

The specimens illustrated on this plate are from the Lower Ceratite Marl, zone of *Prionolobus rotundatus*, Chideru, Salt Range, Pakistan. They are deposited in the British Museum of Natural History, London. All figures X 1.

Figs. 1–3. *Menuthionautilus kieslingeri* Collignon. 1. Mature phragmocone (the cross section is illustrated in text figure 3), B.M.N.H. C10433, holotype. 2. Ventral view of small paratype, B.M.N.H. C10438c. 3. Side view of small paratype, B.M.N.H. C10438b.

Fig. 4. *Grypoceras* (*Grypoceras*) *aemulans* n. sp. B.M.N.H. C47068, holotype.

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2

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PLATE 2

BREVIORA

Museum of Comparative Zoology

Cambridge, Mass. September 23, 1953 Number 21

THE ANCESTRY OF THE FAMILY NAUTILIDAE

By Bernhard Kummel

The evolutionary history of the ammonoids and nautiloids is quite parallel. The nautiloids had their greatest radiation in the early stages of their history — in the Ordovician and Silurian — and declined rapidly in numbers of genera per period until the Recent. The ammonoids, however, displayed a slow start in the middle Paleozoic but reached a peak of development in the Upper Triassic and again in the Jurassic and Cretaceous. Both groups experienced periods of mass extinctions with few surviving lines which formed the starting point for new and generally even greater radiations. The transition from the Permian to the Triassic witnessed wholesale extinctions among the ammonoids with only the Xenodiscidae and Pronoritidae giving rise to the early Triassic stocks (Spath, 1934). The nautiloids at this critical boundary did not undergo such radical changes. A number of late Paleozoic families did become extinct but three major stocks continued uninterrupted into the Triassic.

The Triassic-Jurassic boundary was, however, a time of crisis for both the ammonoids and the nautiloids. Only a single stock of ammonoids survived the Rhaetic to give rise to the vast numbers of Jurassic and Cretaceous forms (Spath, 1934). The Triassic families of nautiloids became extinct by the Norian. No Rhaetic nautiloids have as yet been described. The general character of Triassic nautiloids is quite distinct from those of the Jurassic.

Spath (1927) was the first to present a comprehensive summary of post-Triassic nautiloids. He placed all the post-Triassic nautiloids in 5 families and 28 genera, many of which were established by him. On the problem of origin of these post-Triassic nautiloids Spath (1927, p. 23) discussed "*Grypoceras* cf. *mesodicum*" (Hauer) recorded by Trechmann (1918, p. 181) from the Upper Triassic (Carnian, bed C) of the Hokonui Hills, New Zealand. Spath considered this species a

Bisiphytes and stated that ". . . there is more probability of *Bisiphytes* being an involute, globose, development of the family Syringonautilidae Mojsisovics, with annular lobe."

Neither Trechmann (1918) nor Spath (1927) illustrated this species and Trechmann's description is inadequate. The purpose of this paper is to illustrate this species and discuss its affinities, and review the problem of ancestry of post-Triassic nautiloids. The author is indebted to Dr. L. F. Spath and Dr. W. N. Edwards for many courtesies during his visit to the British Museum (Natural History) and for permission to study Trechmann's specimen. The photographs were taken in the British Museum by its staff photographer.

The uniqueness of this species (here named *Bisiphytes trechmanni* n. sp.) lies in the fact that it is the only tangible clue we have to deciphering the evolutionary patterns of the nautiloids across the Triassic-Jurassic boundary. Spath (1927, p. 23) recognized that Trechmann's specimen was not a *Grypoceras* and goes on to mention it as ". . . indistinguishable from typical *Bisiphytes*, with their strong strigations, especially on larger whorls, annular lobe and only slightly sinuous septa." With this statement I am in complete agreement.

The evolutionary patterns of Triassic nautiloids can be summarized as those of culminating trends which began in the Carboniferous. Three distinct lines of development are represented. One includes the Paranautilidae, Clydonautilidae, and Gonionautilidae characterized by globular, occluded conchs and tendency towards sinuosity of the suture. The second major group consists of the Tainoceratidae including most of the "ornamented" Triassic nautiloids. This stock is generally evolute and with nodes and ribs. The Tainoceratidae includes Pennsylvanian, Permian, and Triassic genera. The third major group comprises the Grypoceratidae and Syringonautilidae. The Grypoceratidae include evolute to involute, generally smooth, compressed nautiloids with tendency for modification of the venter. This family also includes Pennsylvanian, Permian, and Triassic genera. The Upper-Triassic developments of this family, *Grypoceras* and *Gryponautilus*, are completely unlike *Bisiphytes trechmanni*. Within the Syringonautilidae there are forms which are very similar in conch patterns to *Bisiphytes trechmanni*. *Syringoceras* and *Syringonautilus* are the most similar to the species described here. These two genera include evolute nautiloids with rounded whorl sections in the early volutions that become more quadrate in outline adorally. The outer whorls have distinct umbilical and ventral shoulders and steep

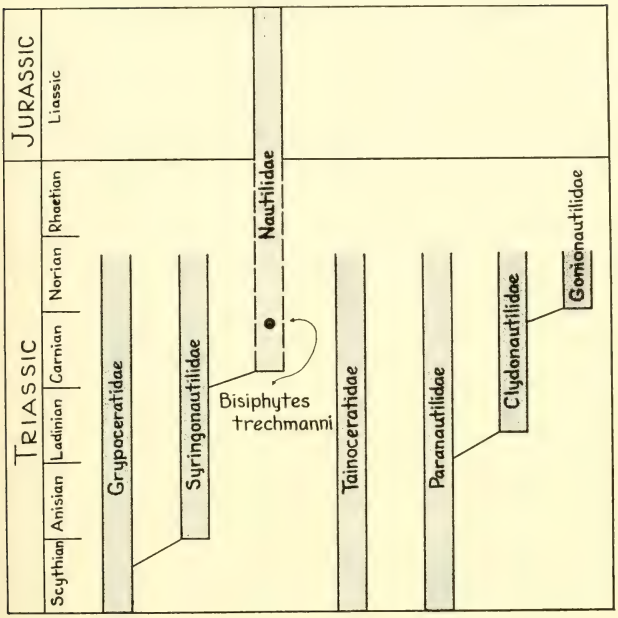

Fig. 1. Phylogenetic diagram illustrating the relationships of the Liassic Nautilidae with the Triassic nautiloid families. The columns representing the Triassic families have been terminated at an arbitrary even line in the Norian. The exact relative extinction dates of these families in the Norian are not known.

umbilical walls. The shell bears fine radial and longitudinal lines. These two genera differ only in the position of the siphuncle; *Syringoceras* has the siphuncle very near but not at the venter, *Syringonautilus* has its siphuncle in a more central position. There are about 14 species of *Syringonautilus,* with 9 species in the Anisian, 5 in the Ladinian, 3 in the Carnian, and 1 indeterminate species in the Norian (Some of these species occur in more than one epoch.) Of *Syringoceras*

there are 17 species recorded, 1 from the Anisian, 3 from the Ladinian 12 from the Carnian, and 1 from the Norian. The pattern of development of these two genera is markedly different in that *Syringonautilus* had a large radiation soon after its appearance and then declined rapidly; *Syringoceras* had its maximum radiation in the Carnian, after a slow development in the Anisian and Ladinian. Both stocks are represented by a single species in the Norian.

The Syringonautilidae also include three aberrant genera of Norian age, namely *Clymenonautilus*, *Juvavionautilus*, and *Oxynautilus*. *Clymenonautilus* has a conch pattern like that of *Syringonautilus*, but has a very sinuous suture convergent to the type of suture present in the Clydonautilidae. *Juvavionautilus*, in its conch shape, is a heterochronus homeomorph of *Domatoceras* of the Pennsylvanian and Permian. *Oxynautilus* is an involute oxycone similar in its conch pattern to *Stenopoceras* of the Pennsylvanian and Permian. *Clymenonautilus* and *Oxynautilus* are monotypic and only 6 species are known of *Juvavionautilus*.

On the basis of the prominent peripheral strigations this species is placed in *Bisiphytes* and not in *Syringoceras* or *Syringonautilus*. The latter two genera are more evolute than *Bisiphytes*, the umbilicus approximating 25 to 30 per cent of the diameter of the conch. The umbilicus of *B. trechmanni* is about 19 per cent of the diameter of the conch. Among typical Liassic *Bisiphytes* the width of the umbilicus ranges from around 20 per cent to completely occluded conches as in *B. simillimus* Foord and Crick. A general evolutionary trend among the coiled cephalopods, except the heteromorph ammonoids, is towards greater involution. Among Triassic nautiloids this trend is very apparent in the *Domatoceras-Crypoceras* line in the Grypoceratidae and the *Metacoceras-Mojsvaroceras* line in the Tainoceratidae. The shape of the whorl section and suture of *B. trechmanni* is quite similar to such species of *Syringoceras* as *S. credneri* Mojsisovics, *S. evolutus* Mojsisovics or species of *Syringonautilus* as *S. lilianus* (Mojsisovics), and *S. longobardicus* (Mojsisovics).

Early Jurassic Nautilidae are accomodated in 5 genera including *Bisiphytes* Montfort, 1808, *Cenoceras* Hyatt, 1883, *Sphaeronautilus* Spath, 1927, *Digonioceras* Hyatt, 1894, *Ophionautilus* Spath, 1927. *Sphaeronautilus* is monotypic, *Digonioceras* has 4 species, and *Ophionautilus* only 5 species. The remaining species of early Jurassic Nautilidae belong to *Bisiphytes* and *Cenoceras*. The Paracenoceratidae, Hercoglossidae, and Cymatoceratidae are derived from the

Nautilidae.

Liassic nautiloids have received rather thorough treatment by Prinz (1906) and Pia (1914). Pia considered the attempt at a phylogenetic arrangement of Liassic nautiloids by Prinz as unsuccessful and premature. Spath (1927) came to the same conclusion. Although Pia (1914, p. 45) was not prepared to offer a detailed phylogenetic arrangement of Liassic nautiloids, he made the following tentative thesis on the evolution of the great majority of Liassic nautiloids:

1.) The conch was probably originally rounded without angular shoulders (perhaps broader than high).
2.) The primitive sculpture consisted of radial and longitudinal striae of equal strength. A smooth shell is a secondary development.
3.) The reduction of the longitudinal striae took place first on the whorl sides, afterwards on the venter.
4.) The siphuncle was originally round.
5.) The annular lobe is a primitive character, its absence a specialization.
6.) The umbilicus was originally open.

Pia considered *Nautilus striatus* as being morphologically very similar to the primitive original stock of Liassic nautiloids.

Of the known Upper Triassic nautiloid stocks, only the *Syringonautilidae* appear to be possible ancestors to the post-Triassic forms; the remaining Triassic stocks are specialized developments morphologically unsuited to be potential ancestors to the known Liassic nautiloids. *Bisiphytes* is thus considered a late Triassic off-shoot of the Syringonautilidae, as first suggested by Spath (1927, p. 23), and in the direct line of ancestry of all later nautiloids.

SYSTEMATIC DESCRIPTION

Family NAUTILIDAE d'Orbigny, 1840

Genus BISIPHYTES Montfort, 1808

BISIPHYTES TRECHMANNI n. sp.

Plate 1, figures 1, 2, 3; text figure 2

Grypoceras cf. *mesodicum* (Hauer). Trechmann, Quart. Jour. Geol. Soc. London, vol. 73, pp. 181–182, 1918.

The single specimen upon which this species is based is a moderately large phragmocone. It measures 71 mm. in diameter, 38 mm. in height of the last whorl, and approximately 50 mm. in width of the

most adoral part of the last whorl. The conch is evolute, the umbilicus measuring 13.5 mm. in diameter. The venter is broadly rounded, as are the ventral shoulders. The whorl sides are somewhat flattened and convergent. The widest part of the whorl is just above the umbilical shoulders which are more sharply rounded than the ventral shoulders. The umbilical wall is steep and convex.

Only fragmentary portions of the shell are preserved. The conch bears fine strigations which are present both on the whorl sides and the venter of the inner whorls. On the most adoral volution the strigations are present only on the venter. On this region there are about 7 lines in a width of 5 mm.

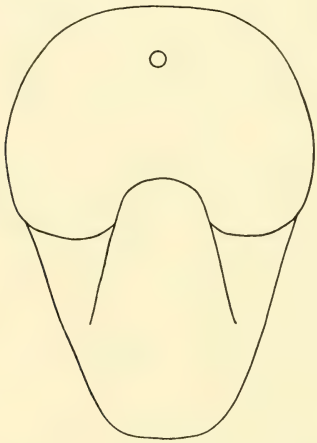

Fig. 2. Diagrammatic cross section of *Bisiphytes trechmanni* n. sp.

The suture forms a broad, very shallow ventral lobe and a slightly deeper lateral lobe. There is an annular lobe. The siphuncle is subventral in position. It is 2 mm. in diameter and lies 7 mm. from the venter.

Occurrence. Upper Triassic, Carnian, Bed C, Otamita, Hokonui Hills, New Zealand.

Repository. British Museum (Natural History) C 21947.

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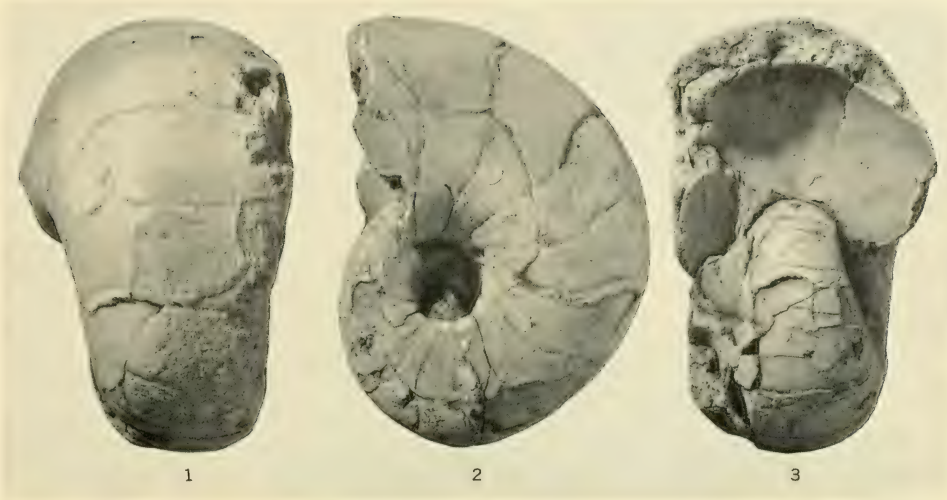

EXPLANATION OF PLATE I

Bisiphytes trechmanni n. sp. Upper Triassic, Carnian, Bed C, Otamita, Hokonui Hills, New Zealand. British Museum (Natural History) C 21947. X1.

BREVIORA

Museum of Comparative Zoology

CAMBRIDGE, MASS. OCTOBER 13, 1953 NUMBER 22

NOTES ON THE ANT, *LEPTOTHORAX OBLIQUICANTHUS* COLE (Hymenoptera: Formicidae)

BY ROBERT E. GREGG

Department of Biology, University of Colorado

A new species of *Leptothorax* was described recently from New Mexico (Cole, 1953), together with some memoranda concerning the distribution of the genus in that state. For some years the writer has been collecting the ants of the neighboring state of Colorado, and in the course of these investigations discovered what appeared to be an entirely distinct form of *Leptothorax*. This ant was confirmed as new by Dr. Creighton, and I was in the process of drawing up a description and the figure of a specimen when Dr. Cole's paper was published. Upon comparing his description with my ants, it is certain that we are both dealing with the same form. Three paratypes were sent to me, and when compared with my specimens prove to be almost identical. The only differences worthy of note are that the Colorado specimens have slight rugulations on the ventral borders of the epinotum (absent in the types), the dorsal petiolar notch is absent, and the ventral petiolar spinule is only weakly developed. Dr. Cole's name for the species obviously has priority over the one about to have been proposed, but since the figure was already finished, and since the ant is so distinctive for the genus *Leptothorax*, it is thought advisable to publish it herewith.

As Dr. Cole points out, the ant differs from the closely related members of the *tricarinatus-texanus* complex, and particularly from *L. t. neomexicanus* in its shorter scapes, larger epinotal spines, and differently shaped petiole, etc. By far the most unusual feature, however, is the pair of huge, subreniform compound eyes, composed of

160 to 180 facets. Dr. Cole makes careful note of the existence of this anatomical character, but unfortunately failed to use it in deriving the specific name.

In his subgeneric allocation of *obliquicanthus*, Cole was constrained to follow the recent changes in the taxonomy of *Leptothorax* proposed by Smith (1950), in which the subgenus *Leptothorax* was replaced by the name *Myrafant*. According to this treatment, Cole designated his new species, *Leptothorax* (*Myrafant*) *obliquicanthus*. But the advisability of Dr. Smith's revision is open to question, and the problem has been discussed at length in an article by Creighton and Gregg submitted to the International Commission on Zoological Nomenclature. In this paper we have taken the position that the changes advocated by Smith will result in endless confusion, not only because of the long established concepts concerning the genus as a whole, but because of the necessity of redefining the characters of the subgenus *Leptothorax*. Before 1950 one group of species with a certain set of traits would belong in the subgenus *Leptothorax*, and after 1950 an entirely different set of species with a different set of characters would be known in the same subgenus. A more incongruous situation could hardly be imagined. We have attempted to rectify the condition by asking the Commission to set aside the Rules and adopt certain names as "nomina conservanda", namely, to retain the taxonomy of *Leptothorax* essentially as it was left by Emery.

Pending the action of the Commission, and until a definite decision is reached by that body, the writer believes unnecessary confusion can be avoided through adherence to the older nomenclature. Such a procedure is not without precedent and would appear to be the much sounder course to follow. Therefore, the treatment which should be given to the recently described species calls for a restitution of the subgeneric name *Leptothorax*, thus:

Leptothorax (Leptothorax) obliquicanthus Cole

The specimens of *obliquicanthus* which I collected came from Higbee, Colorado, in the southeast part of the state, twenty miles south of La Junta. They were obtained from two general habitat types, semi-moist meadow near the Purgatoire River, and high dry, short grass plains above the river valley. The approximate elevations of these sites are 4400 ft. and 4500 ft. respectively. Dr. Cole's specimens were taken twelve miles south of Santa Fe, New Mexico, in a

grassy area. Though the species is now known to exist over a fairly wide territory, much collecting will be required to learn the precise nature of its range.

The unusual size, position, and form of the eyes in *obliquicanthus* raises the question of their possible function and adaptive value. Dr. Creighton (1930, p. 121), in discussing a similar phenomenon in *Solenopsis* (*E.*) *macrops* Santschi, points to Santschi's observation that convergent adaptation may be involved. In *Oxyopomyrmex*, according

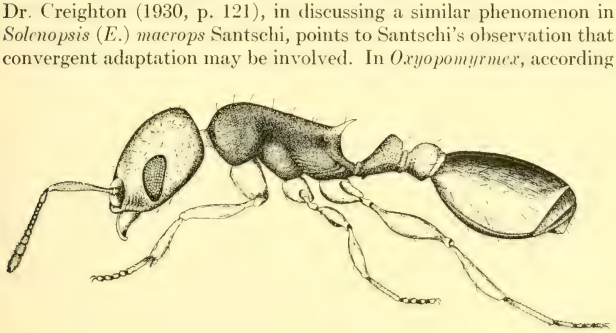

Figure 1. *Leptothorax obliquicanthus* Cole, worker. Drawn from a specimen collected by the writer at Higbee, Colorado.

to Santschi, the workers stop at the entrance of the nest before going out, in such a position that their large, elongate eyes are able to scan the surroundings. It may not be too much to suggest that the oversized eyes of these three forms represent analagous developments, and that their functions are connected with diurnal habits in open areas.

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BREVIORA

Museum of Comparative Zoology

CAMBRIDGE, MASS. OCTOBER 23, 1953 NUMBER 23

A NEW SPECIES OF *HYPOGNATHA* FROM PANAMA

BY ARTHUR M. CHICKERING

Albion College, Albion, Michigan

Among the less common argiopid spiders found in Panama is a species of the curious genus *Hypognatha*. Up to the present time only one species of this genus has been known from Central America, *H. nasuta* O. P. Cambridge, originally described from Mexico. During the preparation of this paper I have been able to study specimens of *H. nasuta* from the collection of the British Museum (Natural History) and collected at the type locality. I have also been able to examine at least two species of the genus from South America in the collection of the Museum of Comparative Zoology. On the basis of this study I have been compelled to consider the species from Panama as new to science.

The study of the new species, together with others available to me, leads to the conclusion that the description of the genus as given by Simon ('94) is wholly inadequate for our present usages and that the whole genus should be carefully restudied and redefined. Such a study is not contemplated at this time. Hence, the present paper will be concerned merely with a description of the new species in accord with my usual procedure.

Acknowledgements are gratefully extended to the following persons for their interest and cooperation in aiding me in the preparation of this paper: Dr. A. S. Romer, Director of the Museum of Comparative Zoology, Harvard College, and Dr. P. J. Darlington, Jr., Curator of Entomology in the Museum of Comparative Zoology, where this paper was completed; Dr. G. Owen Evans and other members of the staff of the British Museum (Natural History) for the loan of valuable material; the donors of the Penrose Fund of the American Philosophical Society, and the Society of the Sigma Xi from both of which I received grants to enable me to pursue field studies in Panama during the summer of 1950.

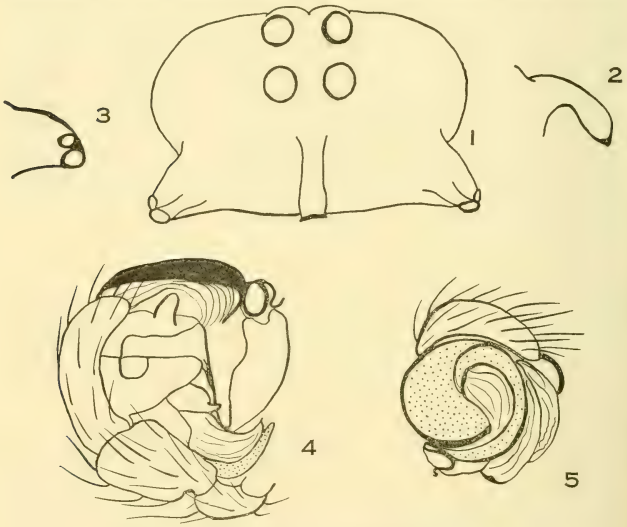
Genus HYPOGNATHA Guerin, 1839

HYPOGNATHA ELABORATA sp. nov.

(Figures 1–10)

Male holotype. Total length 3.12 mm. Other features essentially as described for the female allotype.

Eyes. Eight in two very strongly procurved rows: PLE pearly white; central ocular quadrangle equally wide in front and behind; almost as wide as long. Ratio of eyes AME : ALE : PME : PLE = 11 : 6 : 10 : 6. PLE irregularly oval, others circular. AME separated from one another by 8/11 of their diameter, from ALE by four times their diameter (straight line distance). PME separated from one another



External Anatomy of *Hypognatha elaborata* sp. nov.
Figures 1–5

Fig. 1. Eyes, clypeus, and cephalic horns of male, from in front.
Fig. 2. Median cephalic horn of male in profile.
Fig. 3. Lateral cephalic horn and LE of male.
Fig. 4. Left male palp, ventro-lateral view.
Fig. 5. Left male palp, distal end of tarsus.

by 9/10 of their diameter. Laterals separated from one another by one half the diameter of PLE. Height of clypeus equal to slightly more than three diameters of AME. Clypeus with a robust curved median horn arising from just above the middle of this area; with a lateral horn on each side bearing at its distal end the two lateral eyes (Figs. 1–3).

Chelicerae. Basal segment .65 mm. long; other features essentially as recorded for the female allotype.

Maxillae, Lip, and *Sternum.* Essentially as described for the female allotype.

Legs. 1243. Width of first patella at "knee" .184 mm., tibial index of first leg 14. Width of fourth patella at "knee" .13 mm., tibial index of fourth leg 15.

	Femora	Patellae	Tibiae	Metatarsi	Tarsi	Totals
	(All measurements in millimeters)					
1.	.975	.487	.769	.975	.430	3.636
2.	.968	.462	.682	.858	.412	3.382
3.	.682	.252	.396	.418	.308	2.056
4.	.902	.330	.550	.770	.363	2.915
Palp	.352	.176	.240	——	.572	1.340

Spines. Even more reduced than recorded in the female. Probably here it would be well to regard them as being replaced by bristles.

Palp. Patella and tibia short, without apophyses. Tarsus complicated; with embolus coiled broadly at distal end of bulb and near the tip it passes into a deeply grooved conductor and completes a second circle at a right angle to the first. Near the middle of the ventral surface there is a long, slender, undulating, lash-like apophysis; near the base there is a stout, two-pronged apophysis (Figs. 4, 5). Altogether different from the palp of *H. nasuta* O. P. Cambridge. If what I have called the embolus at the distal end of the bulb were lacking, then what I have termed the median apophysis probably would be termed the embolus. This raises certain questions about the identification of parts in *H. nasuta* O. P. Cambridge as well as in this species.

Abdomen. 2.34 mm. long; 2.470 mm. wide about two fifths from base where it is widest; the chitinous ring nearly surrounding spinnerets and anal tubercle less well developed than in female; covers somewhat less of the carapace than in the female; dorsum much less regularly subdivided into angular areas than in female; four dorsal sigilla very clear.

Color in alcohol. Essentially as recorded for the female except as recorded below: carapace and chelicerae somewhat lighter in color; testudinate dorsum without such distinct angular areas; with many whitish sub-chitinous granules so that nearly the whole dorsum is whitish; venter much less clearly marked with brown oblique and transverse bands.

Female allotype. Total length 3.185 mm. Carapace so nearly covered by abdomen that ordinary description of this part is nearly impossible. Observations on a paratype show that median longitudinal thoracic groove is lacking; considerably constricted opposite interval between first coxae and palpi; posterior two thirds smooth; anterior third granular on surface; appears to be devoid of spinules and with a scant supply of hair.

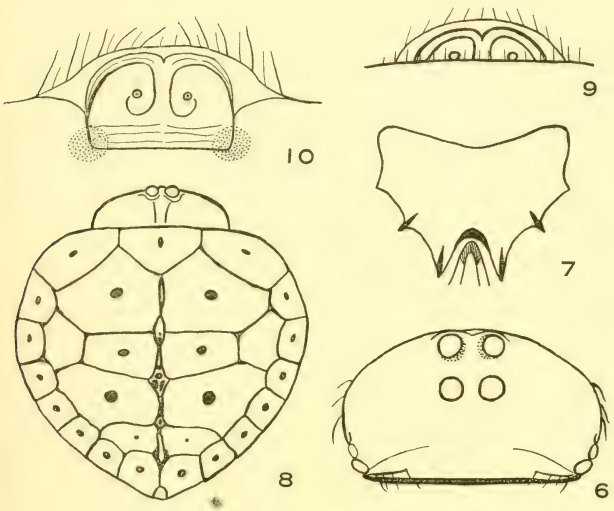
Eyes. Eight in two rows; all dark except PLE which appear light perhaps because of degeneration; both rows would ordinarily be considered strongly procurved. Viewed from above, posterior row nearly straight; viewed from in front, both rows strongly procurved; central ocular quadrangle equally wide in front and behind, slightly longer than wide. Ratio of eyes AME : ALE : PME : PLE = 11 : 8 : 11 : 7. AME separated from one another by a little less than their diameter, from ALE by four times their diameter. PME separated from one another by a little less than their diameter, from PLE by five times their diameter. Laterals separated from one another by one eighth of the diameter of ALE. PLE irregularly oval; all others circular (Fig. 6). Height of clypeus equal to 37/11 of the diameter of AME.

Chelicerae. Basal segment .75 mm. long; somewhat receding; quite robust; basal boss well developed; fang well developed and finely dentate along inner margin particularly in basal half; fang groove with five teeth along promargin and four along retromargin (observed clearly on dissected paratype but confirmed on allotype).

Maxillae. Slightly convergent; broadly rounded along outer margin where serrula is very extensive.

Lip. Wider than long in ratio of about 2 : 1; gradually narrowed to a rounded point distally; deeply grooved transversely at base. Sternal suture distinctly procurved.

Sternum. Of a modified cordiform shape; wider than long in ratio of about 4 : 3; deeply notched at posterior end; the notch is filled by a sclerite in the form of a peg; with posterior coxae separated by about 1.3 the width of one of them; with a scant covering of short stiff bristles (Fig. 7).



External Anatomy of *Hypognatha elaborata* sp. nov.

Figures 6–10

Fig. 6. Eyes and clypeus of female allotype, from in front.
Fig. 7. Sternum of female allotype.
Fig. 8. Female allotype, dorsal view.
Fig. 9. Epigynum of allotype, posterior view.
Fig. 10. Epigynum of dissected paratype to show complete posterior exposure.

Legs. 1243. Width of first patella at "knee" .195 mm., tibial index of first leg 14. Width of fourth patella at "knee" .1624 mm., tibial index of fourth leg 15.

	Femora	Patellae	Tibiae	Metatarsi	Tarsi	Totals
	(All measurements in millimeters)					
1.	.975	.520	.715	.921	.440	3.571
2.	.975	.520	.650	.814	.418	3.377
3.	.812	.380	.418	.418	.352	2.380
4.	1.100	.440	.616	.780	.400	3.336

Spines. True spines almost completely lacking. A few weak spines may be recorded as follows: First leg: femur dorsal one near middle, one prolateral near distal end; tibia prolateral one near proximal end. Third leg: patella apparently with a dorsal distal spinule. Three tarsal claws throughout. Palpal claw: pectinate in a single row.

Abdomen. 2.73 mm. long; 3.25 mm. wide near middle; very much flattened; with a soft membranous ring nearly surrounding the six spinnerets and anal tubercle; tracheal spiracle with a well chitinized lip just anterior to base of anterior spinnerets. Covers nearly two thirds of the carapace. Dorsal angulate areas clearly separated by narrow lines (Fig. 8).

Epigynum. Epigynal plate a broad, rounded ridge with openings and other characteristic parts directed posteriorly and partly hidden by genital groove (Fig. 9). Posterior margin more clearly shown in dissected paratype (Fig. 10).

Color in alcohol. Carapace a light rich reddish brown with nearly black indefinite flecks and streaks. Sternum much the same but with more dark flecks. Chelicerae a rich amber color. Legs yellowish with many dark flecks varying much on the different segments. Abdomen: the strongly chitinized dorsum is generally light brown but is finely pitted and dotted with many brownish specks; the angular areas are separated by yellowish lines; the venter is provided with several brown oblique and transverse bands alternating with narrow light lines.

Type locality. Male holotype from the Barro Colorado Island, C. Z., July, 1934; no mature male paratypes; female allotype from the same locality July, 1936. Paratype females from the same locality July–August, 1936; July, 1939; July–August, 1950. Several immature males and females July, 1936, 1939.

Hypognatha nasuta O. P. Cambridge, 1896

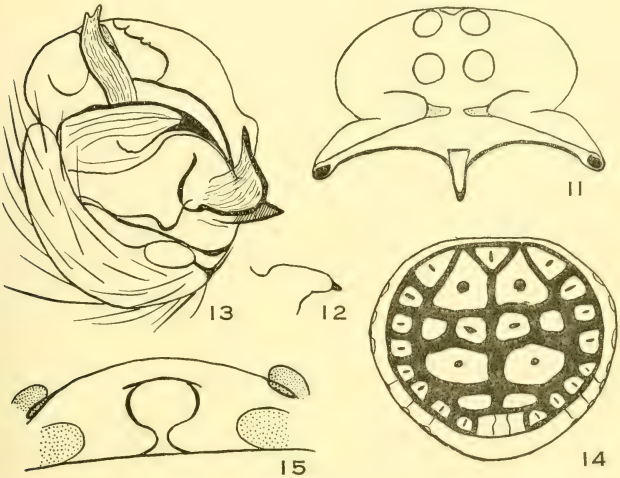
(Figures 11–15)

H. nasuta F. P. Cambridge, 1904
H. nasuta Petrunkevitch, 1911

The following notes are based upon a study of specimens of this species loaned by the British Museum (Natural History); collected April, 1905 at Teapa, Tabasco, Mexico; from the Godman and Salvin collection.

Male. At the base of each lateral cephalic horn there is a groove ending in a shallow pit beneath each AME. The bases of the lateral

horns are relatively much broader than in *H. elaborata* sp. nov. and the clypeus is extended into a broad shelf from near the ventral border of which the medial horn extends (Figs. 11, 12). The cephalic part of the cephalothorax is roughened by shallow pits. The palp appears to follow the same general pattern as in *H. elaborata* sp. nov. with the long slender median apophysis extending much as in the new species, but what is here regarded as the long coiled terminal embolus in the new species is a relatively short tube following closely the conductor and very slightly coiled (Fig. 13). The dorsum is essentially like that in the new species.



External Anatomy of *Hypognatha nasuta* O. P. Cambridge

Figures 11–15

Fig. 11. Eyes, clypeus, and cephalic horns of male.
Fig. 12. Median cephalic horn of male in profile.
Fig. 13. Left male palp, ventro-lateral view.
Fig. 14. Dorsal view of female abdomen.
Fig. 15. Epigynum of female; a somewhat posterior view.

Female. Angular areas on the chitinized dorsum are bordered by much broader margins than in the new species (Fig. 14) and the whole abdomen is much deeper and more robust. Total length 3.51 mm.; abdomen 3.055 mm. long; greatest width 3.445 mm. Ratio of eyes AME : ALE : PME : PLE = 9 : 6 : 9 : 6. AME separated from one another by slightly less than their diameter, from ALE by slightly less than four times their diameter. PME separated from one another by slightly less than their diameter, from PLE by slightly less than five times their diameter. The epigynum has a central depressed region posterior to a strongly chitinized ridge (Fig. 15).

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BREVIORA

Museum of Comparative Zoology

CAMBRIDGE, MASS. JANUARY 27, 1954 NUMBER 24

A NEW FAMILY, A NEW GENUS, AND TWO NEW SPECIES OF BATOID FISHES FROM THE GULF OF MEXICO

BY HENRY B. BIGELOW
AND
WILLIAM C. SCHROEDER[1]

The West Indian-Gulf of Mexican region is proverbially poor in skates as compared with the more northerly coastal waters of the Atlantic; so much so, indeed, that two specimens only, of *Raja akleyi* Garman 1881, from the Yucatan Bank and nearby, were the only skates that had been reported in scientific literature from any part of the Gulf prior to 1921. This is fewer than one is likely to find, stranded, along the beaches of Cape Cod during an hour's stroll on any summer day. And while a second species, *R. texana* Chandler 1921, is now known to occur in some numbers around the northern shores of the Gulf from Florida to Texas, it was not until the winter and spring of 1938–1939 that the trawling campaigns of ATLANTIS brought to light the presence of a varied skate fauna at depths greater than 200 fathoms around the coasts of Cuba.

Examination of these, of collections of skates in the U. S. National Museum that had been taken by the ALBATROSS many years ago, and of others taken recently by OREGON of the U. S. Fish and Wildlife Service, had brought to light ten new skates of the genera *Raja*, *Breviraja* and *Cruriraja*,[2] up to 1950, from Cuban waters and from the northern part of the Gulf; also of a new genus, *Springeria* Bigelow and

[1] Contribution No. 657 from the Woods Hole Oceanographic Institution.

[2] These are *Raja lentiginosa* Bigelow and Schroeder 1951; *R. olseni* Bigelow and Schroeder 1951; *R. teevani* Bigelow and Schroeder 1951; *Breviraja atripinna* Bigelow and Schroeder 1950; *B. colesi* Bigelow and Schroeder 1948; *B. cubensis* Bigelow and Schroeder 1950; *B. sinusmexicanus* Bigelow and Schroeder 1950; *B. yucatanensis* Bigelow and Schroeder 1950; *Cruriraja atlantis* Bigelow and Schroeder 1948 and *C. poeyi* Bigelow and Schroeder 1948.

Schroeder 1951, representing the little known family Anacanthobatidae.

We can now report the capture by OREGON of another new *Raja* from the northern part of the Gulf, and of a skate-like fish, from the southern part, for which a new family seems needed.

Family PSEUDORAJIDAE, Fam. Nov.

Family characters. Rajoidea without dorsal fins; with well developed caudal fin extending around tip of tail and forward along lower side of tail about as far as along upper side, supported by a great number of very slender ray-like strands, apparently cartilaginous;[1] with outer-posterior margins of pelvic fins nearly straight, or even slightly convex if spread widely; anterior wall of spiracle with a transverse row of low vertical ridges, representing the vestiges of the embryonic gill filaments; pelvis with transverse element nearly straight, each of its outer corners with a short projection directed forward.

The batoid fish, described below as *Pseudoraja fischeri*, falls clearly among the Rajoidea because of the shape of its pelvis and of the persistence of vestiges of the embryonic gill filaments on the anterior wall of its spiracles (mentioned above). It is rajoid, too, in general appearance; in the nature of its dermal armature; and in the fact that its snout terminates in a fleshy process, for a corresponding structure tips the snout in the rajoid family Anacanthobatidae, represented in the Gulf of Mexico by the genus *Springeria* Bigelow and Schroeder 1951, and perhaps in the skate *Psammobatis mira*(Garman)1877[2] but is not known to occur in any of the Myliobatoidea. The presence of a rostral projection (albeit a short one) from the front of its cranium, and its lack of a tail spine, point toward a rajoid rather than a myliobatoid relationship, though neither of these two features is strictly alternative, between the two suborders, for a few rajoids lack the rostral cartilage, while it is a matter of common knowledge that some myliobatoids lack the tail spine.

On the other hand, a myliobatoid relationship, rather than a rajoid, is suggested for *Pseudoraja*, superficially, by the shape of its pelvic fins with straight or slightly convex outer contour, and by the large size and the shape of its caudal fin. But, again, we are dealing with

[1] The caudal fin-folds of various species of *Raja*, that we have examined under the microscope, are supported similarly.

[2] Garman (Proc. Boston Soc. Nat. Hist., Vol. 19, 1877, p. 207) described the snout of *mira* as terminating in an "acute point", which is pictured as prickly in his classic monograph (Mem. Mus. Comp. Zool., Vol. 36, 1913, Pl. 27, Figs. 3–5).

characters that are not as strictly alternative as seemed once to be the case. Thus the pelvics of *Pseudoraja* are approached closely, in shape, by those of *Sympterygia* (undoubtedly a rajid) in which they are so weakly concave in outline, when spread, that they can hardly be characterized as "bilobed".[1] And while the caudal fin is a close counterpart, in size and shape, of the caudals of the myliobatoid family Urolophidae, it is similar in shape in the rajid genus *Springeria* Bigelow and Schroeder 1951, though smaller.

With *Sympterygia* and *Pseudoraja* wholly bridging the gap, in shape of pelvic fins, between the typical Rajoidea in which these are definitely bilobed, and the Myliobatoidea, in all of which their outer contour is continuously convex, it is evident that the precise shape of these fins must be abandoned, as alternative between these two suborders. But the shape of the pelvis itself is sharply diagnostic in this regard, for while it is nearly straight transversely, or bowed forward only very slightly, in all the Rajoidea for which its shape is known[2] and has a projection (longer or shorter) directed forward from each of its outer corners, its transverse element is bowed strongly forward, and it has no prepelvic projections at the outer corners in all the myliobatoid families where it has been studied, but has a prepelvic process in the mid-line in some of them.[3]

The presence or absence of vestiges of the embryonic gill filaments on the anterior wall of the spiracle, after birth, seems equally diagnostic, as between the suborders Rajoidea and Myliobatoidea, for these are present in various species of *Raja*, in *Breviraja*, in *Cruriraja*, in *Springeria* and in *Pseudoraja*, whereas no trace of them is to be seen in any of the myliobatoids where we have sought them, which include representatives of *Dasyatis*, *Taeniura*, *Gymnura*, *Urolophus*, *Myliobatis*, *Aetobatus*, *Rhinoptera* and *Mobula*.

The taxonomic significance of this character was forecast, in fact, more than a century ago, by Johannes Mueller's (Arch. Anat. Physiol. Jahrg. 1841, p. 274) discovery that these vestigial gill folds are present after birth in skates and in torpedos, as they are in many sharks, but not in *Myliobatis*, in *Dasyatis* (referred to by him as *Trygon*), or in *Taeniura*. But while the contrast in this respect, between skates and sting rays, has been mentioned repeatedly since Mueller's day,

[1] For illustration of the pelvics in *Sympterygia*, see Garman, 1913, Pl. 27, Fig. 1.

[2] This includes representatives of the genera *Raja*, *Breviraja* and *Cruriraja* (Family Rajidae), and of *Springeria* representing the Anacanthobatidae. The shape of the pelvis is not known for the somewhat problematical family Arhynchobatidae.

[3] See Garman (1913, Pls. 53, 54) for illustrations of the pelvis in Dasyatidae, Potamotrygonidae, Gymnuridae, Urolophidae, Myliobatidae and Mobulidae.

we can not find that any of our predecessors have taken account of it in defining the two subfamilies in question.

Pseudoraja, in short, falls clearly among the Rajoidea. But its lack of dorsal fins with its well developed caudal fin forbid its reference either to the Rajidae or to the somewhat problematical family Arhynchobatidae, while the nature of its pelvic fins, the large size of its caudal, and its well developed dermal armature set it apart, equally sharply, from all known members of the Anacanthobatidae. Hence the necessity for a new family, lest it be left a taxonomic orphan.

Genus PSEUDORAJA Gen. Nov.

Generic characters. Pseudorajidae with shape of disc, and of tail relative to disc, as in skates of the family Rajidae; pelvic fins very large, wing-like, with anterior outline directed outward, about transverse to main axis of disc; front of cranium with a rostral projection, longer or shorter; a deep pit on ventral surface of head on either side, close posterior to nostril but entirely separate from latter. Other characters those of family Pseudorajidae. Type species *Pseudoraja fischeri* Bigelow and Schroeder.

PSEUDORAJA FISCHERI,[1] Sp. Nov.

Figures 1, 2

Type. Female, 479 mm. long, southern part of Gulf of Mexico, near Campeche Bank, Lat. 22°42′N, Long. 86°41′W, 225 fathoms, OREGON Sta. 726; bottom temp. 47.7°F; U. S. Nat. Mus. No. 163368.

Study material. Also female 428 mm.; female 262 mm., and juvenile male 262 mm. from same station.

Description. Proportional dimensions, in per cent of total length, of female 479 mm. long (type) and female, 428 mm.

Disc: Extreme breadth, 48.6, 50.3; length 39.5, 40.0.

Snout length in front of:[2] orbits 9.2, 8.4; in front of mouth 12.3, 12.1.

Orbits: Horizontal diameter 4.4, 4.7; distance between 3.0, 3.0.

Spiracles: length 2.3, 2.2; distance between 6.0, 6.1.

[1] Named in recognition of E. N. Fischer's skillful portrayals of elasmobranchs.

[2] From base of rostral filament.

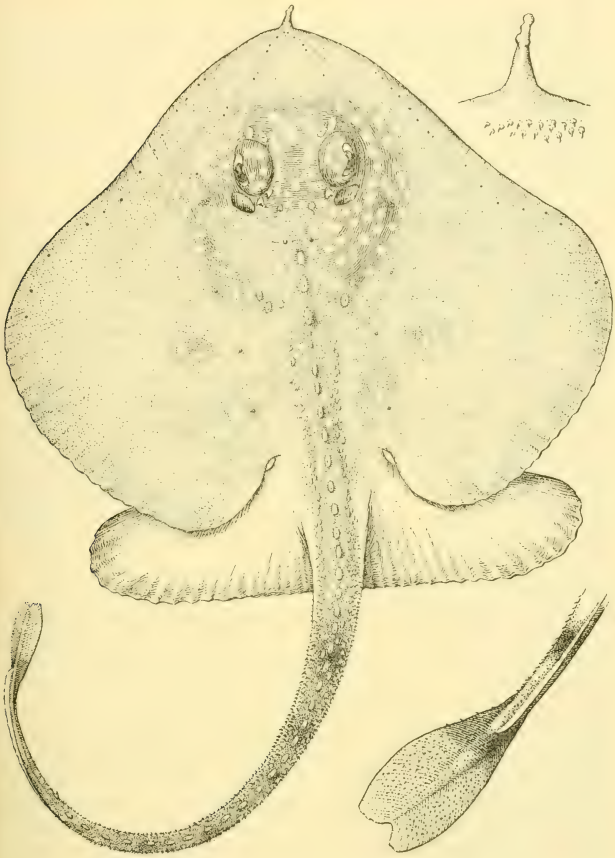

Fig. 1. *Pseudoraja fischeri*, type specimen 479 mm. long. Rostral filament and side view of caudal fin to larger scale. U. S. Nat. Mus. No. 163368.

Mouth: breadth 4.7, 4.6.

Nostrils: distance between inner edges 6.4, 6.3.

Gill openings: lengths, 1st 1.0, 1.1; 3rd 1.2, 1.2; 5th 0.7, 0.7; distance between inner ends, 1st 11.2, 11.8; 5th 6.9, 7.0.

Caudal fin: length of base, upper 7.7, 8.2; lower 6.9, 7.3.

Distance: from tip of snout to center of cloaca 39.5, 38.5; from center of cloaca to tip of tail 60.5, 61.5.

Pelvics: anterior margin 17.7, 17.7.

Teeth: $\frac{28}{26}$ in type; $\frac{30}{26}$ in female of 428 mm.; $\frac{28}{28}$ in male of 262 mm.

Disc, from base of rostral filament, about 1.2 times as wide as long, so broadly rounded in front that its anterior contour is not susceptible to angular measurement; the rostral filament about $\frac{1}{3}$ as long as orbit, soft, narrow triangular, tapering to very slender but blunted tip.

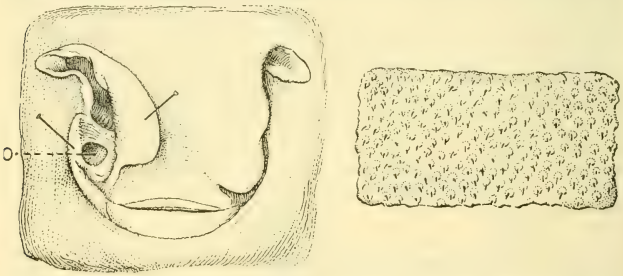

Fig. 2. *Pseudoraja fischeri.* Left, ventral view of oronasal region with right hand nasal flap rolled back to show nostril and oronasal pit (0). x about 1. Right, skin from central part of pectoral, to show arrangement of prickles. x about 3 1/2.

Anterior margins of pectorals weakly concave abreast of eyes and spiracles, convex thence rearward; outer corners broadly rounded; posterior margins moderately convex; posterior corners rather abruptly rounded; inner margins weakly convex, to axils. Tail slender, its dorsal surface nearly flat, but its sides and lower surface rather broadly arcuate in cross section; its breadth at axils of pelvics about 80 per cent as great as length of orbit, its length, from center of cloaca to tip, about 1.5 times as great as distance from center of cloaca to base of rostral filament; the lateral caudal folds confined to about posterior $\frac{1}{3}$ of tail and extending a little beyond origin of caudal fin, very narrow along their anterior part, but widening rearward until

nearing the level of the caudal fin. The breadth of the folds is about ½ as great as the height of the caudal above its axis, or about ⅔ as great as the length of the first gill openings.

Entire upper surface of disc including skin above eyes, and of tail close set with minute, sharp pointed prickles curving rearward, except close along extreme posterior edge of pectorals; also two large and one small thorn around anterior contour of orbit, the small one the outermost; a group of two large and one smaller thorn close behind each orbit, with the largest member of the group the outermost; two thorns on each shoulder, with a median line of three from nuchal region to pectoral girdle; these are followed, after a short gap, by a row of about 32 along mid-line of disc and of anterior ⅔ of length of tail, the first five to pelvic girdle small, the next 17 or 18 large and conspicuous, with strongly striate bases, those farther rearward, along tail, progressively smaller; and the posterior ¼ of tail without large thorns, recalling conditions in *Raja senta*. Either side of mid-dorsal belt of disc and upper side of tail with 3–4 irregular rows of closely crowded thornlets; no thorns large or small (apart from the prickles) anywhere on pectorals. Caudal fin generally prickly above caudal axis, but with only a few scattered prickles below axis. Upper surface of pelvics wholly naked. Lower surface of disc and of pelvics naked, also of anterior part of tail rearward to abreast of rear corners of pelvics, but densely prickly thence rearward to caudal fin. The dermal armature of small specimens essentially similar, except the mid-dorsal thorns fewer (about 26 in 2 specimens of 262 mm.).

Snout (from base of terminal filament) to front of orbits about 2.9 times as long as distance between orbits, its length in front of mouth about 1.9 times as great as distance between inner edges of exposed nostrils. Orbit about 1.5 times as long as distance between orbits and about 2.1 times as long as spiracle. Upper eyelid bowed downward, and eye with a rounded black velum with crenate margin above pupil, as in skates of the genera *Raja* and *Breviraja*.

Outer lip of spiracle smooth; vestigial gill-ridges on anterior surface of spiracle about 12 in number, rounded, their edges completely fringed with minute lobelets. Nasal curtains smooth edged; those of the two sides of head actually separated by a space about ½ as wide as distance between exposed nostrils, but seemingly interconnected there by a weakly outlined fold of skin. Outer (posterior) margin of nostril smooth, slightly expanded in scoop-like form; the exposed nasal aperture noticeably small.

An interesting feature of this new skate is that if the nasal curtain, on either side, be rolled inward, and the skin between nostril and corner of mouth be spread outward, a deep pit is exposed, close behind the nostril, but its entrance separated from the latter by a bar of stiff tissue. The pit is directed forward-upward, and it extends so far that a probe inserted into it can be felt clearly from the dorsal side of the head, through the overlying skin. And it is so voluminous on the two larger specimens as to allow the entrance of an ordinary match stick, or of a slender lead pencil. The presence of this pit was wholly unexpected, for nothing comparable to it is to be seen, either in *Raja*, in *Dasyatis*, or for that matter in any of the other batoids that we have examined in this respect, and these include representatives of all known families, both of Rajoidea and of Myliobatoidea, excepting only the Arhynchobatidae.

Mouth nearly straight transversely in females and in juvenile males, its contour not known for adult males. Teeth $\frac{28\,(\text{type})-30}{26\,(\text{type})-28}$; those of females and of juvenile males low, rounded, in quincunx mosaic; those of mature males not seen; the tooth bands attached rather loosely to the jaws.

First gill openings about $\frac{1}{6}$ as long as distance between exposed nostrils; third gills a little longer than first; fifth gills about 7/10. Distance between inner ends of first gills about 1.8 times as long as between inner edges of exposed nostrils and about 1.7 times between inner ends of fifth gills.

No dorsal fins. Caudal fin a little longer than distance between exposed nostrils, its height above caudal axis about $\frac{1}{4}$ as great as its length, its depth below axis about $\frac{4}{5}$ as great as its height above latter; upper and lower caudal origins about even. Upper margin continuously rounded; lower margin less strongly so; tip broadly rounded, notched abreast of tip of axis in type specimen, but merely ragged there on slightly smaller specimen (428 mm.) and continuously rounded terminally in small specimens (262 mm.), evidence that its terminal contour on the type has resulted from mutilation.

Pelvic fins more widely spreading than in most other rajoids, and of very diagnostic shape, the anterior outline directed nearly transversely to the main axis of disc and tail, and so long that the tips of the pelvics reach outward considerably beyond the margins of the overlying portion of the pectorals. Anterior margin nearly straight; outer corners broadly rounded; outer posterior (distal) margin straight, or

very weakly convex if spread widely; only very weakly scalloped to conform to positions of tips of radial cartilages; the rear corner abruptly rounded. The inner margin is so short that the pelvics of the two sides appear to be separated only by a shallow notch. But the condition of the clasper described below shows that this is not evidence of a partial fusion of the inner edges of the pelvics with the sides of the tail, but only that these edges are relatively shorter than they are in the skates of the genera *Raja* and *Breviraja*. The anterior margin of the fin soft and fleshy; the first radial cartilage noticeably stout, especially toward its base; the other radialia slender and flexible.

Point of separation of clasper from inner margin of pectoral, in juvenile male, about even with the axil of the fin; tip of clasper already reaching a little beyond rear corner of pelvic. Claspers of mature male not seen.

It is interesting, in this connection, that the claspers of juveniles of *Springeria* originate considerably in advance of the apparent axils of the fins, evidence of partial fusion of the inner margins of the latter with the sides of the tail (Bigelow and Schroeder, 1951, Fig. 1).

Front of cranium with a low, blunt tipped rostral projection, reaching forward a little beyond level of fronts of nasal capsules; tips of anterior rays of pectorals reaching nearly to tip of snout. Pelvis with transverse element nearly straight, each outer corner with a short prepelvic projection.

Color. Upper surface ashy gray, deepening rearward to sooty gray along posterior $\frac{1}{5}$ of tail; disc rearward from orbits with many small vaguely outlined pale spots, most conspicuous on head, and along mid-belt thence rearward, less so outward over pectorals; outer parts of pectorals unspotted. The large thorns white basally, their tips gray. Anterior part of disc also with a rather conspicuous pattern of black dots marking the mucous pores as follows: a) an irregular row along outer margin of each pectoral from a little behind tip of snout to about abreast of axis of greatest breadth; b) a row of 7–8 on each side, diverging from tip of snout to a little in front of level of front of orbits; c) a row of four, extending in anterior-posterior direction close in front of each orbit; d) a larger black spot, marking a cluster of three or four pores a little outward and rearward from the posterior edge of each orbit; e) a similar black spot (3 or 4 pores) either side of the mid-line in nuchal region, close in front of the first large mid-dorsal thorn; f) one black dot (1 pore) on inner part of each pectoral, in shoulder region; a second in line of orbit a little rearward from shoulder

region; and a third about midway thence toward axil of pectoral. Tail irregularly pale spotted along anterior ½, with a few scattered pale spots thence rearward to caudal fin; also with a vaguely outlined dark cross-bar a little posterior to level of tips of pelvics, followed, after a short gap, by a second such bar. Upper surface of pelvics ashy gray, without pale spots.

Lower surface of disc ash gray with irregular sooty cloudings, these most conspicuous on abdominal region; the pectorals of a more brownish, the mid-belt of a more bluish cast. Lower surface of pelvics ashy gray, with bluish cast; lower surface of tail pale grayish white with irregular ashy-gray cloudings, and with the dark cross-bars of the upper surface encroaching downward across the sides rather conspicuously.

The pale spots on the disc are much less conspicuous, and less definitely outlined on small specimens than on large, but the dark cross-bars on the tail are more conspicuous.

Size. The larger specimens being female, and our only male a juvenile, their sizes give no clue to the dimensions to which this skate may grow.

Habits. Apparently confined to rather deep water.

Range. So far known only from the southern side of the Gulf of Mexico, at the locality listed above, page 4.

Family RAJIDAE

Raja fuliginea, Sp. Nov.

Figures 3, 4

Study material. Type specimen. A juvenile male, 306 mm. long, OREGON Sta. 534, northwestern part of Gulf of Mexico, Lat. 27°32′N, Long. 93°02′W; trawl haul at 400–450 fathoms, April 11, 1952; U. S. Nat. Mus., No. 163367.

Distinctive characters. This skate resembles *R. bathyphila* Holt and Byrne 1908 so closely in the general arrangement of thorns and prickles, in proportional dimensions in general, and especially in the very dark coloration of the lower surface of disc and tail that we took it for a specimen of *bathyphila* on our first cursory glance. But a closer examination showed that it differs from *bathyphila* in a considerably more obtuse anterior contour of its disc (Fig. 3A) and especially in the fact that the entire lower surface of the tail, apart from a very narrow median stripe, is densely prickly from base to tip (naked in

bathyphila). The prickles, also, on the upper surface of disc and tail are coarser than on *bathyphila*, and there are no naked areas, while its pelvics are largely prickly on the upper surface (naked in *bathyphila*)

The only skate yet known from the northwestern Atlantic, or from the Gulf of Mexico, other than *R. bathyphila*, with which *fuliginea* shares a uniformly dark colored lower surface is *R. olseni*. But it differs from *olseni* in blunter snout and tail prickly below. It shares a tail prickly below with *R. mollis*. However, it is marked off from *mollis*, not only by its dark lower surface (*mollis* is pale yellowish or whitish below) but also by a much thornier tail and disc, by its considerably more convex anterior contour, also by its harder rostral cartilage. Since these divergences concern characters that are not generally subject to much individual variation among the members of its genus, a new specific name seems requisite for it. We suggest *fuliginea* because of the sooty chocolate hue of its lower surface.

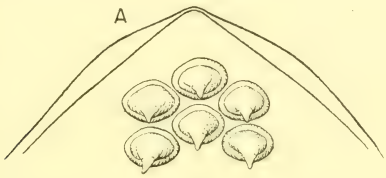

Fig. 3. A. Outlines of front of disc; outer, *Raja fuliginea*, type specimen, and inner, *Raja bathyphila* from southern slope of Georges Bank to show difference in shape. B. Upper teeth of *Raja fuliginea* from near center of mouth. x about 15.

R. fuliginea, like *bathyphila* and *olseni*, parallels *R. badia* Garman 1899, *R. trachura* Gilbert 1892, and *R. abyssicola* Gilbert 1895 of the Pacific coast of Central and North America in its uniformly dark lower surface. But it differs sharply from all three of these in various respects.

Description. Proportional dimensions, in per cent of total length. Juvenile male, 306 mm. long; OREGON Sta. 534, northwestern part of Gulf of Mexico, Lat. 27°32′N; Long. 93°02′W; 400–450 fathoms.

Disc: Extreme breadth 46.3; length 42.8.

Snout length in front of: orbits 9.8; mouth 12.1.

Orbits: horizontal diameter 3.9; distance between 3.6.

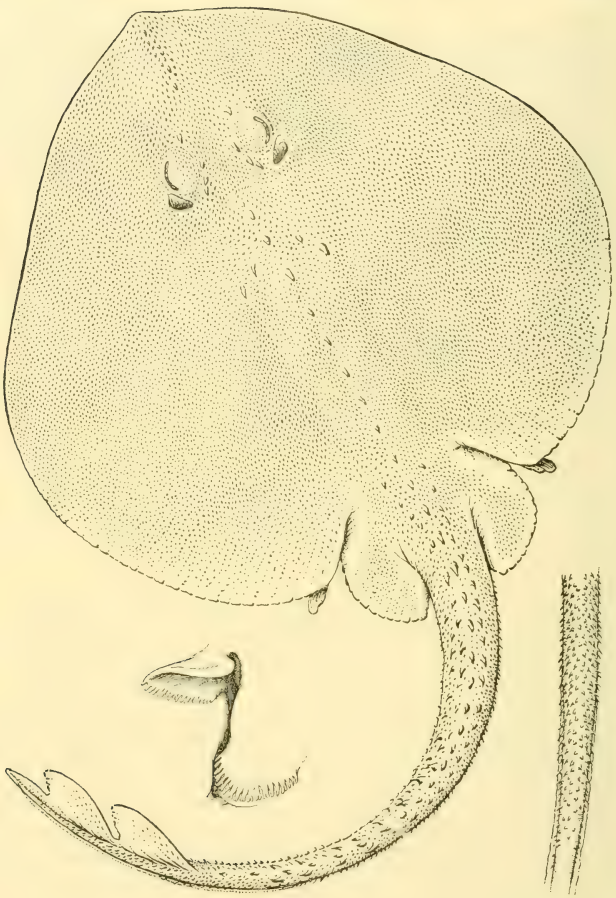

Fig. 4. *Raja fuliginea*, type specimen 306 mm. long, U. S. Nat. Mus. No. 163367, with right hand nostril and nasal curtain x about 3.4, and under side of tail in advance of first dorsal fin, x about 1.1.

Spiracles: length 2.3; distance between 6.7.
Mouth: breadth 5.9.
Nostrils: distance between inner ends 6.2.
Gill openings: lengths 1st 1.3; 3rd 1.3; 5th 1.0; distance between inner ends, 1st 12.9; 5th 7.5.
Distance: from tip of snout to center of cloaca 39.3; from center of cloaca to 1st dorsal 45.4; to tip of tail 60.7.
First dorsal fin: vertical height 2.9; length of base 5.9.
Second dorsal fin: vertical height 2.6; length of base 5.6.
Interspace between: 1st dorsal and 2nd dorsal 0.0.
Pelvics. anterior margin 14.4.
Teeth: $\frac{41}{42}$.

Disc about 1.1 times as broad as long, so broadly and continuously rounded in front that the anterior contour is not susceptible to angular measurement; the tip of the snout projecting slightly, and blunted. The pectoral margins only very slightly concave abreast of eyes and spiracles, and broadly and continuously rounded thence rearward, around to posterior corners, without definitely marked outer corners; posterior corners rather abrupt; inner margins nearly straight.

Axis of greatest breadth about $\frac{2}{3}$ (66%) of distance rearward from tip of snout toward level of axils of pectorals.

Tail with very narrow lateral folds along posterior $\frac{2}{5}$ (38–39%) of its free length posterior to axils of pelvics; its length from center of cloaca about 1.2 times as great to first dorsal and about 1.5 times as great to tip as from center of cloaca to tip of snout.

Upper surface of disc, also upper surface and sides of tail, densely set everywhere with rather coarse prickles curving rearward, or minute thornlets, a very narrow band close along posterior edges of pectorals being the only naked area.

Also a group of small recurved thorns along anterior part of rostral ridge; four larger thorns in a line around inner side of each orbit; one thorn in mid-line in nuchal region; six large thorns on scapular region, two of these on either side with two in mid-line in pattern shown in Figure 4; a line of six smaller thorns along mid-line of disc from scapular region nearly to level of axils of pectorals, followed, thence rearward, by 3–4 irregular rows along anterior $\frac{1}{5}$ of tail, succeeded by two thorns in mid-line, to first dorsal fin. First and second dorsals, and caudal membrane sparsely prickly; anterior lobes of pelvics

naked; posterior lobes rather densely prickly over inner and posterior portions.

Lower surface of disc naked throughout. Lower surface of tail densely set with prickles or thornlets similar to those of upper surface, except that a very narrow median stripe is naked, both along anterior ⅔ of tail, and, again, rearward from level of origin of first dorsal fin.

Snout in front of orbits about 2½ times as long as orbit; its length in front of mouth about twice as great as distance between exposed nostrils. Orbit about as long as distance between orbits and about 1.7 times as long as spiracle. Nasal curtain deeply fringed, with about 18 lobelets; expanded posterior (outer) margin of nostril fringed, also. Mouth nearly straight, the lower jaw arched forward only a very little centrally; its breadth about 1/5 (21%) as great as breadth of disc at level of mouth, and only about 6 per cent as great as distance from tip of snout to tip of tail. Teeth $\frac{41}{42}$, with low triangular cusp, blunted at tip, arranged in quincunx in juvenile male, probably also in female.

First pair of gill openings about 22 per cent as long as breadth of mouth; distance between inner ends of first gills about 2.1 times as long as between inner edges of exposed nostrils, and about 1.2 times between inner ends of fifth gills.

Dorsal fins about alike in shape and equal in size, their bases confluent, without intervening thorn or prickles. Caudal membrane, posterior to second dorsal, about ⅔ as long as base of second dorsal.

Pelvic fins deeply concave outwardly; outer margin strongly scalloped around the concavity with three marginal lobes on the one fin, four on the other; but with the positions of the radial cartilages only faintly indicated thence rearward; anterior lobe narrow, fleshy with rounded tip; posterior lobe strongly convex; rear corner abrupt; anterior margin of anterior lobe about 90 per cent as long as distance from its point of origin to rear corner of posterior lobe; rear corners extending back from about ¼ of distance from level of axils of pectorals toward first dorsal fin.

Firm rostral cartilage detectable by touch as reaching very nearly to extreme tip of snout; tips of anterior rays of pectorals falling a little short of level of tip of rostral cartilage.

Color. Upper surface of disc, tail and pectorals uniform dark ashy gray, darkest on anterior lobes of pelvics, but without definite dark markings anywhere. Lower surface of disc sooty chocolate to nearly black, and noticeably darker than upper surface on head and around

outer belts of pectorals. A sub-triangular area in region of cloaca reaching forward about to pelvic girdle, and vaguely outlined, irregularly interrupted areas on the inner parts of the pectorals rearward from the gill region are of a somewhat paler sooty chocolate hue, perhaps partly as a result of rough treatment in the trawl. Lower surfaces of pelvics dark sooty, except pale on tips of anterior lobe; sides and lower surface of tail of a very dark ashy-gray, except somewhat paler along a narrow median stripe.

Size: The type (and only known) specimen being a juvenile male, it gives no clue to the size to which this skate may grow.

Habits and range. The depth of capture (400–450 fathoms), added to the dark color of its lower surface, marks *fuliginea* as a deep water species. Present indications are that the upper boundary to its usual range lies not far from 400 fathoms, else specimens of a skate made so conspicuous by its dark lower surface would almost certainly have been noticed among the catches of the many trawl hauls that have been made in the Gulf at lesser depths. Nothing more than this is known of its habits.

The locality of capture lies in the northwestern part of the Gulf, some 100 miles off Galveston. It is an interesting question for the future whether *fuliginea* is restricted to the Gulf, or whether it has simply been overlooked in the open Atlantic.

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BREVIORA

Museum of Comparative Zoology

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A NEW MIOCENE SPECIES OF PELUSIOS AND THE EVOLUTION OF THAT GENUS

BY ERNEST WILLIAMS

Among the reptilian remains from the island of Rusinga in Lake Victoria, Kenya Colony, sent for determination to the British Museum (Natural History) are the greater part of the carapace and a smaller part of the plastron of an apparently new species of *Pelusios*.

Dr. W. E. Swinton, who suggested that I examine the unidentified chelonian remains from British East Africa, has kindly consented that I describe the new form. Accordingly I name it:

PELUSIOS RUSINGAE, new species

Type: Coryndon Museum Ru F3617 — a partial carapace and plastron.

Horizon: Miocene of Rusinga Island, Lake Victoria, Kenya Colony.[1]

Diagnosis: A *Pelusios* belonging to the *adansonii-gabonensis* section of the genus, distinguished by the following combination of characters: a very depressed shell (height included in length about four times); the carapace expanded posteriorly; the vertebral region very shallowly excavated, quite without keel; first vertebral scute much larger than vertebral 2 and wider than long; vertebrals 2, 3, and 4 slightly longer than wide; mesoplastra extremely narrowed medially, barely meeting.

The living species of *Pelusios* fall into two sections:

One, which is northern and western in distribution, comprises two species, *P. adansonii* and *P. gabonensis*. This group is characterized by having the anterior lobe of the plastron relatively long and the abdominal scutes relatively short, so that the sulcus between the abdominal scutes is included more than twice in the length of the anterior lobe. Also the mesoplastra are more or less tapered medially, so that the hyoplastra anteriorly and the hypoplastra posteriorly (or the hypoplastra only) are longer medially than laterally, projecting

[1] For a summary of the geology and the Miocene fauna of Rusinga and adjacent areas see Kent (1944).

into and filling up the interval left by the tapered margins of the mesoplastra.

The other group within the living members of the genus is less restricted in distribution. One of its species — *P. subniger* — overlaps most of the range of the first group and in fact extends beyond that range on the west to the Cape Verde Islands. On the east this same species extends to Zanzibar, the Seychelles, Mauritius and Madagascar. On the north, however, this species does not extend beyond British East Africa into the Sudan range of *P. adansonii*.

The group typified by *P. subniger* is distinguished by having the anterior lobe shorter and the abdominal scutes longer so that the sulcus between the abdominal scutes is included less than twice in the length of the anterior lobe, and by having the mesoplastra not tapered and presenting straight transverse contacts with both hyo- and hypoplastra.

The relationships of *P. rusingae* are clearly with the first of these two living groups: the tapered mesoplastra clearly indicate this position. From *P. adansonii*, however, *P. rusingae* differs (1) in the more depressed shell, (2) in the absence of any vertebral keel, (3) the first vertebral wider than long, (4) greater size. From *P. gabonensis* it differs in (1) the posterior expansion of the shell, (2) the absence of any trace of vertebral keel, (3) the second to fourth vertebrals longer than wide. From both species it differs in the more extreme medial narrowing of the mesoplastra. The table below summarizes the shell characters of the two Recent and the fossil species (I utilize the data of Loveridge, 1941, which I have, however, verified on other material).

P. adansonii	*P. gabonensis*	*P. rusingae*
Sulcus between humerals 3–4 times as long as that between pectorals.	Sulcus between humerals 1½–2 times as long as that between pectorals.	Unknown
Mesoplastra tapered medially only posteriorly, thus a transverse hinge with the hyoplastra but an oblique suture with the hypoplastra.	Mesoplastra tapered medially both anteriorly and posteriorly, thus an oblique suture with both hyo- and hypoplastra.	Mesoplastra strongly tapered medially anteriorly and posteriorly, hardly meeting.
A keel on the anterior four vertebrals throughout life.	A nodose keel in the young, lost in the old.	No keel, the vertebral region somewhat depressed.

Vertebrals about as long as broad in adults.	At least vertebrals 1 to 3 broader than long in adults.	Vertebral 1 wider than long, vertebrals 2–4 longer than wide.
Height in length about 2.6 times.	Height in length 2.3 to 3.8 times.	Height in length about 4 times.
Shell distinctly broadened posteriorly.	Shell not broadened posteriorly.	Shell distinctly broadened posteriorly.
Known maximum size: 185 mm.	Known maximum size: 259 mm.	Estimated size: 245 mm.

P. rusingae thus contrives to combine some of the characters of both the two living members of its group. It occurs, also, outside — south and east — though not far outside, the present limits of its group. Only *P. subniger* of the alternative group is known from Lake Victoria today.

Three fossil species of *Pelusios* have been previously described: *P. rudolphi* Arambourg from the Lower Pleistocene of Omo, founded on a partial plastron and carapace (type in Paris Museum); *P. dewitzianus* v. Reinach represented by fragments from the Middle Pliocene of Wadi Natrun (type formerly in Munich, now destroyed); and *P. blanckenhorni* Dacqué, a skull from the Lower Miocene of Moghara (type in Berlin?). In addition and not previously recorded there are abundant fragments (Nairobi Museum) and a complete shell (British Museum No. R 5761) of *P. sinuatus* (a still living species of the *P. subniger* group) from Bed I, Pleistocene of Olduvai.

The fossil *P. sinuatus* need not be compared with *P. rusingae*. The Olduvai material is clearly referrable to the Recent species which still occurs in this area.

P. rudolphi needs as little attention. The type (examined at the Paris Museum) resembles closely old specimens of Recent *P. sinuatus*. It may provisionally be accepted as ancestral to the *P. sinuatus* of the later Pleistocene and of the Recent.

P. dewitzianus was originally described on quite inadequate material which, however, was still sufficient to place it as a member of the *P. subniger* group. It was redescribed from much better material by Dacqué (1912), who at the same time discovered that a supposed Pliocene species of *Pelomedusa* (*P. pliocenica* v. Reinach) was a synonym of this species. *P. dewitzianus* as a member of the alternative

group requires no comparison with *P. rusingae*.

There remains, however, *P. blanckenhorni*, which is from a deposit apparently equivalent in age and very similar in fauna to that of the Lower Miocene of Rusinga Island, but 2000 miles distant. *P. blanckenhorni* and *P. rusingae* cannot be compared, since one is based on a skull, the other on a shell. The skull of *P. blanckenhorni*, inadequately described and figured only in dorsal view by Dacqué, seems similar to that of *P. gabonensis*. It may, therefore, belong to the same group within the genus as *P. rusingae*, and it is not impossible that the latter is a synonym. But to hazard the identity of forms 2000 miles distant from one another and represented by incomparable parts would be without substantial basis.

Furthermore, a special element of doubt attaches to species belonging to this section of the Pelomedusidae which, as with *P. blanckenhorni*, are founded solely upon the skull. It is a remarkable fact that *Pelusios* and *Pelomedusa*, though quite distinct in shell characters, have extremely similar skulls. The skulls of the two Recent genera can be told apart only by characters which in many other groups would be counted of specific value only. Reference of a fossil skull, therefore, to either genus is a doubtful procedure unless there is the confirmation of an associated shell. In the present case this leaves us with the possibilities that *P. blanckenhorni* may be either specifically identical with *P. rusingae*, or specifically different, or it may belong to a different genus. This conclusion may appear as absurd as it is unsatisfactory, but this is a dilemma not uncommon in paleontology, and it is decidedly worthwhile to recognize and emphasize the difficulty of evaluation of fossil species based on parts not comparable. All that can be suggested as a method of decision, which, while arbitrary, is still not devoid of reasonableness, is that material from deposits of the same or equivalent ages and geographically close may be provisionally associated if any apparently valid grounds for such association exist; but geographic distance or difference in geologic age carry with them a presumption of distinctness which must be countered by stronger arguments than those that — for the moment — suffice in the other case.

P. rusingae and *P. blanckenhorni* (if this is really a *Pelusios*), occurring in the Lower Miocene, are the oldest members of this genus. It will be useful to consider them against the background of the early history of the family of which they are a part.

The family *Pelomedusidae* is certainly very old; it probably stems

ultimately from the pleurosternids of the Upper Jurassic and the Cretaceous. Unfortunately the form which has been suggested as the oldest representative of the family, *Platycheloides nyassae* Haughton, is incompletely known and doubtful as to age. It has small laterally placed mesoplastra and is therefore not an obviously primitive form. Mesoplastra meeting in the midline are certainly primitive for turtles and *Pelusios* would therefore be more primitive in this respect, *unless* the larger mesoplastra of *P. lusios* are a secondary development (see below). The single known character in which *Platycheloides* differs from *Pelomedusa* as ordinarily conceived — the absence of the median plastral fontanelle — does not in fact separate it from that genus, since, as I have been able to determine on British Museum specimens from Uganda and the Sudan, the median fontanelle is sometimes lacking in even small specimens of *Pelomedusa*. The beds from which *Platycheloides nyassae* derives are Cretaceous in age, but to what part of the Cretaceous they belong is not known. This African form is therefore not certainly older than the better known pelomedusids of the Upper Cretaceous of North and South America and Europe, though it is probably as old. Widespread already in the Cretaceous, the pelomedusids continued so in the early Tertiary with representatives in North and South America, England, Italy (del Zigno, 1887), Egypt, Congo and India.

It is a curious fact that every one of these older members of the family that are sufficiently known is pelomedusine in type rather than pelusiine, that is: the mesoplastra are small and lateral elements, as in *Pelomedusa* and *Platycheloides*, not large elements meeting in the center of the plastron as in *Pelusios* and the pleurosternids. Nor is it at all likely that this observation is an artifact resulting from a failure to recognize as pelomedusids those with complete mesoplastra. A pelomedusid with large complete mesoplastra is immediately distinguishable from a pleurosternid by the total absence of inframarginal scutes.

The uniformity in the condition of the mesoplastra in the oldest members of the family is an intimation that the pelomedusine type of mesoplastra (small and lateral) may be primitive for the family and that the pelusiine type (large and centrally meeting) may be secondarily derived from the pelomedusine.

With this suggestion the known facts about *Pelusios* are fully congruent. The members of the genus *Pelusios* form a structural series in regard to the size of the mesoplastra, *P. rusingae* having the most

reduced mesoplastra, *P. gabonensis* the next, *P. adansonii* next, and the *P. subniger* group the most fully developed mesoplastra. A structural series is always ambiguous unless the time dimension can be added, but *P. rusingae* as the oldest shell belonging to the genus seems to provide this time element.

The similarity of the skulls of *Pelomedusa* and *Pelusios* further suggests relationship, and the existence of a species of *Pelomedusa* (*P. progalcata* v. Reinach) anterior in time (Lower Oligocene) to the earliest (Lower Miocene) *Pelusios* further supports the view that *Pelusios* is a relatively late and specialized genus directly derived from *Pelomedusa*.

P. rusingae is thus a fortunate discovery, offering a much needed term in an evolutionary series — a series apparently affording an example of the reversal of an evolutionary trend.

Acknowledgements: I am indebted to Dr. W. E. Swinton for the opportunity of examining and describing this fossil, to Prof. C. Arambourg for the privilege of examining the type of *P. rudolphi* at the Paris Museum, to Dr. H. W. Parker for permitting me to examine comparative material of the Recent genus in the Reptile Section, British Museum (Natural History), and to M. Jean Guibé for similar permission in Paris. The photographs in Plates 1 to 4 were made by Peter Green and are reproduced by permission of the British Museum (Natural History). This study is part of a series of researches made possible by the grant of a Guggenheim Fellowship during the year 1952–53.

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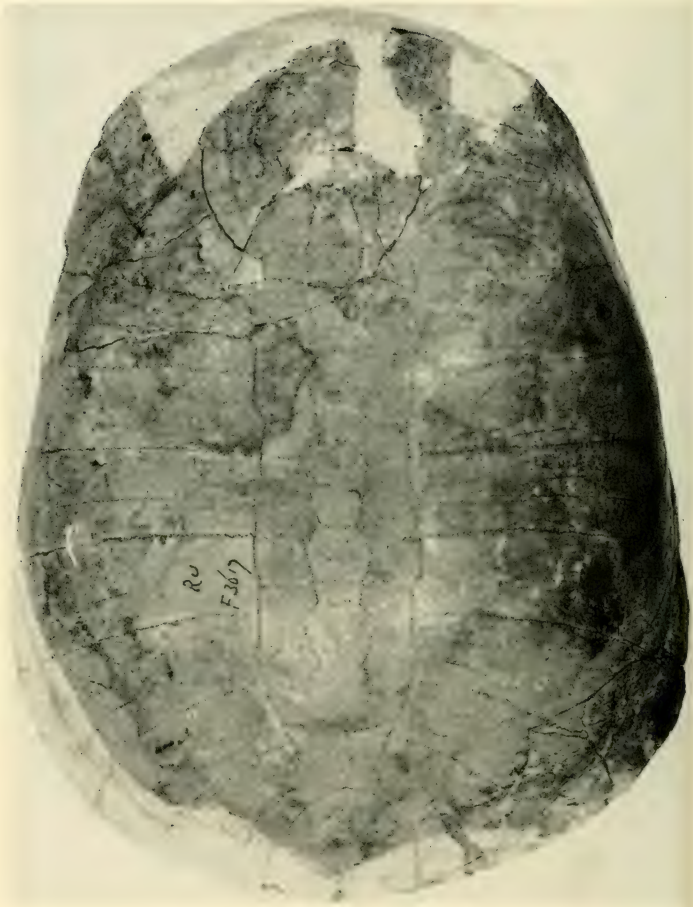

PLATE 1

Pelusios rusingae, dorsal view of type shell.

PLATE 2

Pelusios rusingae, ventral view of type shell.

PLATE 3

Pelusios sinuatus (B.M.N.H. R. 5761), dorsal view of shell from Bed 1, Pleistocene of Olduvai.

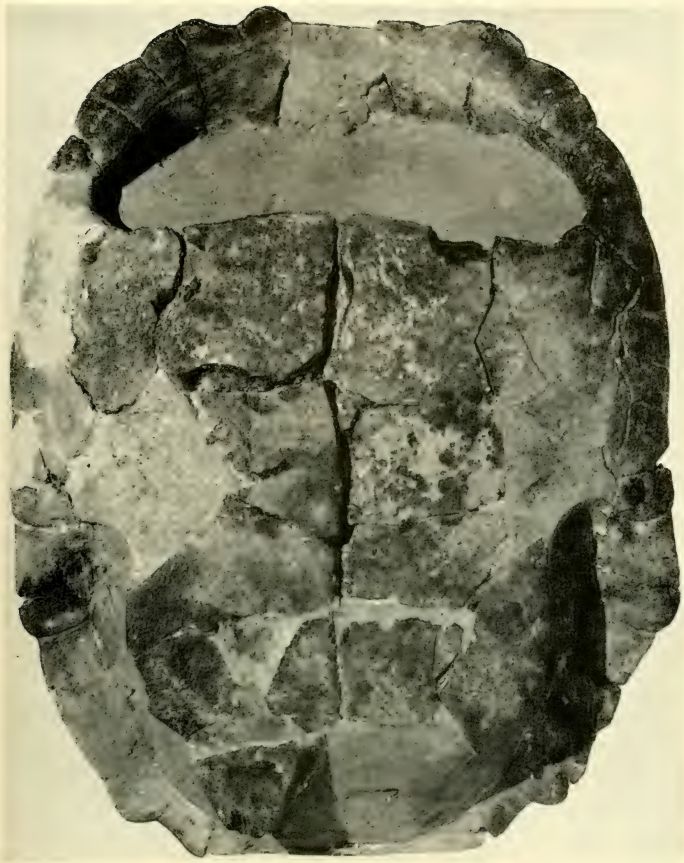

PLATE 4

Pelusios sinuatus (B.M.N.H. R. 5761), ventral view of shell from Bed 1, Pleistocene of Olduvai.

BREVIORA

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A PRELIMINARY LIST OF THE EARTHWORMS OF NORTHERN NEW JERSEY WITH NOTES

BY H. DAVIES

Dover, New Jersey

The literature of North American earthworms contains few references to New Jersey and no paper has appeared describing worms collected in that state. Moore (1895, p. 473) refers to three species found within 30 miles of Philadelphia (*Allurus tetraedrus, Bimastos palustris* and *Sparganophilus tamesis*), and Eaton (1942) mentions four lumbricids found at Alpine, N. J. and Edgewater, N. J. This paper is therefore presented as a contribution to the knowledge of the fauna of New Jersey.

Collections of earthworms were made above a line drawn east and west through Princeton, N. J. with a concentration in the area of Morristown and Dover. Notes are given on the living conditions of the various species where such are thought to add to our knowledge.

The term 'clitellate' is used in this note to describe worms with recognizable features of clitellar development regardless of the stage. Where the tubercula pubertatis only are present, 'aclitellate' is used, while worms having no indications of clitellum or tubercula are considered 'juveniles'.

Family LUMBRICIDAE

Genus ALLOLOBOPHORA Eisen 1874

ALLOLOBOPHORA ARNOLDI Gates 1952

Morristown, Mt. Kemble Road, in soil by stream; April 15, 1950, 2 clitellate specimens.

Andover, in rich loam in woods, April 12, 1953, 4 clitellate specimens, many juveniles.

Dover, in garden soil, April and May 1953, 3 clitellate specimens, many juveniles.

Morristown, James St., garden, May 19, 1953, 13 clitellate and 1 aclitellate specimens.

Mt. Freedom, in sandy ditch, May 19, 1953, 5 clitellate specimens.

Beatystown, in meadow, May 1953, 7 clitellate specimens.

Mt. Tabor, under stones in garden, June 8, 1953, 3 clitellate and 11 aclitellate (post sexual?) specimens.

This is the third record of a species which has hitherto been found in Massachusetts and New Hampshire. The specimens correspond to the diagnosis given by Gates except that the number of segments covers a slightly wider range as the data from 21 specimens show: 139(2), 140(1), 141(2), 143(1), 147(1), 153(1), 154(1), 160(1), 164(1), 174(1), 177(2), 181(1), 182(2), 183(1), 184(2), 187(1). In each of these the anal segments were normal in appearance; however amputation is prevalent in this species and some might prove to be amputees.

Allolobophora caliginosa (Savigny) 1826

Dover, in garden soil (clay), June 8, 1953, 2 clitellate specimens.

Mt. Tabor, under stones in garden, June 10, 1953, 2 clitellate specimens.

Pompton Plains, in marshy meadow, June 1953, 3 clitellate specimens.

Paterson, in garden top soil, June 1953, 2 clitellate specimens.

These specimens are tentatively assigned to *caliginosa*, but do not conform to the description given by Cernosvitov and Evans (1947, p. 13), as Table I illustrates. In every case a grey-brown pigment is present on the dorsal surface, the clitellum being a dull yellow.

Description of tubercula pubertatis:

Specimen No. 150a band-like, indentation at xxxii on upper side.

150b band-like, indentation at xxxii on upper side.

157a band-like, tripartite origin, on xxxi–xxxiii. Intersegmental lines distinct.

157b L. As 157a.

R. Band-like, slightly indented at 31/32 and 32/33.

161a, 161b, 162a, 162b: Band-like, tripartite origin, on xxxi–xxxiii.

In each case the lateral portion of the tuberculum is translucent while the median portion is opaque and appears as a band.

Table I

External characteristics of *Allolobophora caliginosa*

Specimen No.	Locality	Number of segments	Clitellum	Tubercula pubertatis	Genital tumescences
150a	Dover	133	27–½35	31–33	30 32 33 34
150b	Dover	179	27–½35	½30–33	30 32 33 34
157a	Mt. Tabor	167	27– 34	31–33	30 32 33 34
157b	Mt. Tabor	156	27– 34	31–33	30 31 32 33 34
161a	Pompton Plains	161	27– 34	31–33	30 32 33 34
161b	Pompton Plains	156	27– 34	31–33	33 34(R)
162a	Paterson	159	27– 34	31–33	30 32 33
162b	Paterson	130 (amputee)	27– 34	31–33	30 32 33 34

ALLOLOBOPHORA LIMICOLA Michaelsen 1890

Morristown, Glen Alpine Rd., in thick mud (pH 5.5) near branch of Primrose Brook, May 27, 1952, 25 clitellate specimens, April 26, 1953, 8 clitellate specimens, June 6, 1953, 5 clitellate specimens, many juveniles at each visit.

Dover, 2nd Street, marshy ground, June 8, 1953, 6 clitellate specimens.

Beatystown, wet meadow, June 10, 1953, 1 clitellate specimen.

The Morristown location is undisturbed marsh and remains wet throughout the year except during the winter freeze. Castings were noted under logs and debris but were not apparent on the surface. Both the Dover and the Beatystown locations are unimproved and are saturated throughout the year. On the June 6 visit to the Norristown location, worms were observed *in copula* approximately 4 inches underground.

This is the second record of this species in North America, Gates (1953, p. 518) having found it in the Arnold Arboretum in Boston. The specimens conform to the description given by Gates, the number of segments corresponding very closely and illustrating the narrow range of this species. Number of segments in 17 specimens: 104(2), 111(1), 112(1), 113(1), 114(3), 117(2), 121(2), 122(1), 123(2), 124(1), 129(1).

Allolobophora longa Ude 1885

Dover, sandy soil in garden, Nov. 1951, 3 clitellate specimens.
Morristown, in garden soil (clay), May 10, 1953, 1 clitellate specimen.
Dover, in garden on 2nd St., June 8, 1953, 3 clitellate specimens.
Beatystown, damp soil in meadow, June 9, 1953, 1 clitellate specimen, 1 aclitellate (post sexual?) specimen.

Genus Bimastos Moore 1893

Bimastos palustris Moore 1895

Flanders, in wet moss in rocky stream near Route 31, Nov. 1951, 4 clitellate specimens.
Hardwick, in ditch in forest (running water), April 1952, 3 clitellate specimens.
Ironia, in wet moss by stream, Succasunna-Ironia Road, May 3, 1952, 1 clitellate specimen.
Swartswood, under moss on log by stream, May 29, 1952, 15 clitellate specimens in association with *E. tetraedra*.
Mt. Freedom, in wet moss on marshy ground by stream, April 27, 1952, 7 clitellate and 1 juvenile specimens.
Shongum, Raynor Road, in very wet sandy loam by stream, March 29, 1953, 4 clitellate specimens.

This species seems to have an affinity for running water and is apparently more restricted in this respect than *Eiseniella tetraedra* with which it is sometimes found. The above confirms Smith (1917, p. 169) who states that *B. palustris* is found in the wet earth of rivers and ponds and has been collected from New Jersey.

Spermatophores were noted on many specimens, the majority having one pair and two specimens having two pairs. One specimen from Swartswood has 53 segments, and one from Mt. Freedom 52 segments, and in each case there was no indication of amputation, the anal segment being normal in appearance. These numbers are smaller than the 80 to 100 given by Smith (1917).

Genus Dendrobaena Eisen 1874

Dendrobaena mammalis (Savigny) 1826

Morristown, Mt. Kemble Road, in moist soil by edge of stream, May 1, 1951, 4 clitellate specimens.

This is the first record for this continent of this species. It is considered to be endemic in the British Isles and has also been collected from a few localities in France. Its occurrence in North America is not unexpected since it has been intercepted on plant materials imported into this country (Gates, 1953, p. 530). The specimens conformed externally to the description given by Cernosvitov and Evans (1947, p. 20).

Dendrobaena octaedra (Savigny) 1826

Morristown, Glen Alpine Road, in rotting wood, June 30, 1952, 17 clitellate specimens in association with *D. rubida.*

Little is known of the distribution of this species in North America although it has been collected in Massachusetts and Michigan in addition to Newfoundland and Greenland.

Dendrobaena rubida (Savigny) 1826

Dover, under rotting grass cuttings in garden, Nov. 10, 1951, 2 clitellate specimens.

Ironia, in damp moss by Succasunna-Ironia Road, May 3, 1952, 2 clitellate specimens.

Morristown, Glen Alpine Rd., in rotting wood, June 30, 1952, 8 clitellate specimens and 1 juvenile with *D. octaedra.*

The records of this worm in North America refer only to collections from New Hampshire, Massachusetts and Maine. However as the writer has also collected it in Michigan, it may be widely distributed.

Dendrobaena subrubicunda (Eisen) 1874

This species is recorded by Eaton (1942) as occurring at Alpine, N. J. It was not found in recent collecting.

Genus Eisenia Malm 1877

Eisenia foetida (Savigny) 1826

This species is found plentifully in farm manure heaps in many North Jersey localities and is sold for bait in the area. It was found in every manure heap where a search was made and only one specimen was collected in any other habitat. However, the current farming practice of spreading manure daily instead of accumulating it, is probably reducing the numbers of *E. foetida* which cannot be said to be as "abundant" as Smith (1917, p. 165) implied.

Eisenia lönnbergi Michaelsen 1894

Morristown, Mt. Kemble Road, in mud at bottom of stream, April 1950, 2 clitellate specimens.

Stokes State Forest, Naponock Brook, in wet moss, April 12, 1952, 1 juvenile.

Ironia, under moss and in wet earth by stream, May 3, 1952, 2 clitellate and 4 juvenile specimens.

Shongum Lake, in wet soil by stream, May 1952, 1 clitellate and 4 juvenile specimens.

Dover, Millbrook Valley, in swampy ground, Aug. 1952, 5 clitellate and 4 juvenile specimens.

Great Swamp, Madison, in wet moss and debris by water (pH 6.0), April 26, 1953, 2 juveniles.

In addition to the above, 4 clitellate and 9 juvenile specimens were obtained from the Pennsylvania bank of the Delaware above Montague, N. J. Some of these were completely submerged under water in gravelly mud.

Table II

External characteristics of *Eisenia lönnbergi*

Condition	Number of segments	Clitellum	Tubercula pubertatis	Regeneration	Remarks
aclitellate	77	—	26–28	56/57	
clitellate	62	24–30	26–$\frac{1}{4}$29	—	Amputee
clitellate	110	$\frac{1}{2}$23–30*	26–28	—	Amputee
aclitellate	129	—	26, 27, 28	—	
juvenile	76	—	—	—	
juvenile	116	—	—	—	
immature	48	—	—	7/8	Apparent head regenerate
clitellate	44	$\frac{1}{2}$24–30	26–28	—	Amputee
clitellate	79	?24–30*	26, 27, 28	—	Amputee
clitellate	51	24–30*	26–$\frac{1}{4}$29	—	Amputee
clitellate	142	?24–30*	26–$\frac{1}{4}$29	—	
juvenile	133	—	—	101/102	
juvenile	132	—	—	47/48	
juvenile	74	—	—	—	Amputee
juvenile	118	—	—	—	
juvenile	132	—	—	—	
juvenile	135	—	—	—	
juvenile	104	—	—	—	
clitellate	125	24–30*	26–$\frac{1}{4}$29	—	

*Clitellum feebly developed.

There are few references to this worm and little has been published regarding its habitat. It has been found in Georgia, Virginia, North Carolina, Connecticut and Massachusetts. Evidently it is widely distributed in northern New Jersey and is probably endemic. Its habitat appears to be restricted to very wet locations in or along the banks of rivers or streams.

The range in segment number of normal specimens from 125 to 142, extends the previous record of 138 segments (Smith 1917, p. 164). The incidence of amputation is very high in the specimens collected, whether this is due to predatism or to autotomy is not known, but none of the specimens autotomized during handling in collection or preservation.

Eisenia rosea (Savigny) 1826

Stokes State Forest, in soil, May 30, 1950, 2 clitellate specimens.
Dover, in clay soil in garden, Nov. 17, 1951, 1 clitellate specimen.
Morristown, in marshy soil, (pH approximately 5.5), June 30, 1952, 1 clitellate specimen.
Swartswood, in mud at edge of stream, May 29, 1952, 1 clitellate specimen.
Layton, in muddy ditch by road, April 3, 1953, 1 clitellate specimen.
Andover, woods near Lackawanna R.R. (Cutoff), in rich black loam, April 12, 1953, 2 clitellate specimens.

Table III
External characteristics of *Eisenia rosea*

Specimen No.	Number of segments	Clitellum	Tubercula pubertatis	Tumescences including *ab*	Tumescences including *cd*
44a	112	25–32	29–½31	26–31	12(L), 13(R)
44b	114	25–32	29–¼31	26–31	11, 12(L), 12(R)
61	109	25–31	29– 30	26–31	11, 12
55	128	26–32	29– 31	26–32	12(R)
122	131	26–32	29– 31	25–32	None
120	130	½26–32	30– 31	12(L), 11, 12(R) 26–32	None

Further description of tubercula pubertatis:
No. 44a Tubercula bluntly elliptical from 28/29 to ½31 without marginal incisions. Intersected by furrow 29/30 only.

44b Shape as 44a but extending to $\frac{1}{4}$31. Slight indication of intersegmental furrow 29/30 on L. side.

61 Tubercula elliptical, from 29/30 to 30/31 with incisions at 29/30 on both margins and distinct furrow across tubercula at 29/30.

55 Tubercula somewhat ill defined ellipse from 28/29 to 31/32 intersected by distinct furrows at 29/30 and 30/31.

122 Single tuberculum on 29 and elliptical mass from 29/30 to 31/32. Furrow 29/30 very distinct. Slight incision on median margin at 30/31 with trace of furrow.

120 Tubercula elliptical from 29/30 to 31/32 with incisions in both margins at 30/31. Indistinct furrow at 30/31.

The presence of tumescences in the clitellar region would appear to identify these specimens as var. *macedonica* Rosa 1893, which is said to be characterized "by the presence of small, mostly lightly coloured glandular papillae along the border of the clitellum" (Cernosvitov and Evans 1947, p. 23). However, this variety is ill defined in comparison with the typical form and positive identification cannot be given.

Genus EISENIELLA Michaelsen 1900

EISENIELLA TETRAEDRA (Savigny) 1826 forma typica

Morristown, at roots of grass in stream, April 15, 1950, 1 clitellate specimen.

Stokes State Forest, in mud under stone in stream, June 10, 1951, 1 clitellate specimen. In wet moss, Naponock Brook, April 12, 1952, 3 clitellate specimens.

Swartswood, under moss in stream, May 29, 1952, 2 clitellate specimens in association with *B. palustris*.

Dover, in marsh near Orchard St. Cemetery, June 20, 1952, 18 clitellate specimens, many juveniles.

Great Swamp, Madison, under wet leaves, May 1952, 8 clitellate specimens.

Buttzville, under wet leaves at edge of Pequest River, April 16, 1952, 8 clitellate and 3 juvenile specimens.

Morristown, Glen Alpine Road, in wet gravel at brook, March and April 1953, 10 clitellate specimens.

One specimen collected at Morristown has the male pores on segment ix with the clitellum correspondingly forward, apparently due to hypomeric regeneration.

On many specimens, setae *ab* of segment xxii are genital, occasionally on prominent lightly colored tumescences.

Genus LUMBRICUS Linnaeus 1758
LUMBRICUS RUBELLUS Hoffmeister 1843

Stokes State Forest, Big Flat Brook, under leaves, May 30, 1950, 1 clitellate specimen.

LUMBRICUS TERRESTRIS Linnaeus 1758

Throughout that part of New Jersey with which we are concerned, this worm is very common in lawns and gardens. It is also found in meadows, particularly where the ground is marshy, and in ditches. It is much in demand by local fishermen and is sold for bait in many places.

Genus OCTOLASIUM Oerley 1885
OCTOLASIUM LACTEUM (Oerley) 1881

Buttzville, under rotting leaves at edge of Pequest River, Aug. 16, 1952, 1 clitellate specimen.

One clitellate specimen was also collected in May 1950 from gravelly mud under water level from the Pennsylvania bank of the Delaware above Montague, N. J. Both specimens have tumescences on *ab* of xxii (one specimen also on xxi, right).

Family GLOSSOSCOLECIDAE
Subfamily SPARGANOPHILINAE

Genus SPARGANOPHILUS Benham 1892
SPARGANOPHILUS EISENI Smith 1895

Morristown, Glen Alpine Rd., in mud under water (pH 5.5) in bay of Primrose Brook, May 27, 1952, 28 clitellate specimens, many juveniles. June 6, 1953, 2 clitellate specimens, many juveniles.

Dover, Second St., in mud at water level of pond (pH of water approximately 8.0), July 16, 1952, 10 clitellate specimens, many juveniles. In stream feeding pond, June 8, 1953, 2 clitellate specimens, 3 juveniles.

Castings were produced by this species at both localities. Early in

April, castings were formed on the surface of the mud, each casting being approximately $\frac{1}{2}$ in. in diameter and $\frac{1}{2}$ in. high and generally conical in shape. As time passed, the number of such castings became greatly increased until in four weeks the whole area was covered. In early May at the Morristown location, castings were observed under water. These increased in size progressively and became supported by grasses growing out of them, becoming eventually a beehive shape with a height of 6 to 8 inches and projecting above water level. As warmer weather arrived, the water level receded, leaving the casting exposed. Examination of these castings revealed numbers of juveniles, adult specimens being obtained only by digging in 4 to 6 inches of mud.

In many cases, both of clitellate and juvenile worms and particularly at the Morristown location, the last 10 to 30 segments were brownish in color, probably indicative of parasitic bodies accumulating in the coelom. Specimens collected at Dover were noticeably shorter than those at Morristown where one specimen possessed 258 segments (165 to 225 according to Olson 1940, p. 9). Posterior regeneration was noted in six specimens.

Family MEGASCOLECIDAE

Genus PHERETIMA Kinberg 1867

PHERETIMA AGRESTIS (Goto & Hatai) 1899

Maplewood, rotting leaf pile in private garden, June 1953, 2 clitellate specimens.

PHERETIMA LEVIS (Goto & Hatai) 1899

Maplewood, rotting leaf pile in private garden, June 1953, 3 clitellate specimens.

PHERETIMA sp.

Maplewood, rotting leaf pile in private garden, June 1953, 2 aclitellate and 1 clitellate specimens.

The last three specimens were athecal as well as anarsenosomphic and could not be referred to either of the two above-mentioned species.

All the pheretimas were found in a garden which contains many oriental shrubs. The species are known to have been present for at least three years and may possibly have been imported directly from the orient.

The leaf pile is under a large conifer and the protection thus afforded, together with the heat generated by the pile may preclude severe winter freezing.

The writer is indebted to Dr. G. E. Gates for the identification of the specimens of *Pheretima* sp.

DISCUSSION

Earthworms of twenty species have now been recorded from northern New Jersey and of these fifteen are recorded from the state for the first time. As might have been anticipated, the majority of species are widely distributed peregrine lumbricids of Eurasian origin. *Dendrobaena mammalis* was found for the first time outside of Europe where it is endemic in the British Isles. This species has been intercepted on plant materials imported into North America (Gates 1953, p. 530), and its appearance, therefore, might have been anticipated.

Bimastos palustris and *Eiseuia lönnbergi* are evidently endemic, and relatively common in their restricted habitat along the banks of streams. Neither of these is listed by Olson (1940) as occurring in New York State and this may imply that northern New Jersey, corresponding roughly to the extent of the ice cap in glacial times, is the northern limit of their general distribution. The glossoscolecid *Sparganophilus eiseni* is presumed to be endemic, although its original source may well be south of New Jersey. That each of the endemic species has a limnic habitat may be of significance as the lack of competition and the ease of colonization thus afforded may have enabled these species to quickly repopulate the barren areas left by the retreating ice cap.

Allolobophora limicola, found in three locations, has just recently been recorded from Boston (Gates, 1953), where it was thought to have been introduced from Europe. As the three New Jersey localities are respectively 10 and 16 miles apart, possibility of a single introduction seems unlikely. *Allolobophora arnoldi* Gates, recently described and only known heretofore from two New England states, was found to be relatively common. It is tentatively considered to be of European origin. The species of *Pheretima* were not expected as no attempt was made to search in ornamental gardens or greenhouses. They are probably of East Asian origin and may have been imported directly with exotic shrubs.

Of the anticipated species, *Bimastos tenuis*, *Allolobophora chlorotica*, and *Dendrobaena subrubicunda* were not found in recent collections. *A. chlorotica* was probably overlooked as it has been found in Rockland County, New York, within a few miles of the New Jersey border. Altogether, collections were made in 55 locations, some of which were found to be heavily populated. Five species were taken from a Dover garden and six species from a pond and adjacent swamp near Morris-

town. *Allolobophora arnoldi*, *A. caliginosa*, *A. limicola* and *A. longa* were found together in one piece of marshy ground in a garden.

In northwestern New Jersey, comprising Warren and Sussex counties, the terrain is characterized by dense woodland rising to 1500–1800 feet. The soil of these woods is largely glacial drift with numerous rocky ledges and outcrops. Searching for earthworms in such localities proved to be most unproductive, possibly due to the fact that the soil drains and dries out very rapidly. However, *Bimastos palustris* and *Eiseniella tetraedra* were found in woodland ditches and streams at isolated locations where the top soil was entirely without worms. Similarly, the top soil of wooded areas in Morris County was found to be largely without worms except where the ground was damp as often denoted by the presence of skunk cabbage (*Symplocarpus foetidus*).

SUMMARY

Twenty species of earthworms have now been recorded from northern New Jersey, including sixteen lumbricids, one glossoscolecid and three megascolecids. Thirteen of these are recorded for the first time from this state, *Dendrobaena mammalis* being reported for the first time outside of Europe. *Bimastos palustris* and *Eisenia lönnbergi* are considered to be endemic and are widely distributed in the northern part of the state. *Allolobophora limicola* was found for the second time outside Europe and in three localities. Three species of *Pheretima* were present in a garden.

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BREVIORA

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ANTERIOR REGENERATION IN A SEXTHECAL SPECIES OF LUMBRICID EARTHWORM

BY G. E. GATES

Records of regeneration, in an anterior direction, at known levels, by posterior pieces of lumbricid earthworms have been brought together in two recent contributions, the first (Gates, 1949) containing all that had been found for *Eisenia foetida* (Savigny) 1826, the second (Gates, 1953) those for the other species that had been studied. Records also have been found of anterior regeneration by a number of specimens, unwittingly used along with *E. foetida*, that must have belonged to yet another species. Identification of this species is the problem with which this note is concerned.

The records involved are available only because it had been found to be "a tedious operation cutting off a definite number of segments". Accordingly, "the number of segments cut off was not counted at the time" . . . but was calculated "after regeneration by the position of the vasa deferentia[1] or segments containing the seminal receptacles" (Morgan, 1895, p. 452). The latter organs, now usually called spermathecae, were said to be normally in segments "9–10–11" (*idem*, p. 455). Such a characterization with reference to paired organs of earthworms certainly can be understood to indicate presence of three pairs of the spermathecae, located one pair each in segments ix, x and xi. But, *E. foetida* has only four spermathecae, usually present, according to various authorities, in ix–x though occasionally in x–xi. The variation does not involve location of spermathecal pores which are on intersegmental furrows 9/10 and 10/11. In view however of the difference in internal location might it be possible that two pairs of spermathecae were so located as to require reference, in most cases, to three segments?

[1] This means: segmental location of the external openings of the deferent ducts, i. e., the male pores. GEG

In this connection location of spermathecae was determined in each older individual (30 clitellate and 4 late juvenile) of the first entire colony of *E. foetida* that was accessible. Some variation as to which of two consecutive coelomic cavities any spermatheca got into as it grew through the parietes was indeed found (Table below). Never-

Table 1

Segmental location of spermathecae in a colony of *E. foetida*

Segments	Number of specimens	
9–10	17	
10	2	
10–11	4	
9, 11	1	
L9, L10, R10	3*	
R9, R10, L10	1	
R10, L10, L11	1	29
L9, L10, R9, L11	1	
L9, L10, R10, R11	1	
R9, R10, L9, L11	1	
R9, R11, L10	1	4
Spiral abnormality in metamerism of the spermathecal region	1	1

* On the left side spermathecae in ix and x, on the right side both spermathecae in x.
Each worm had four spermathecae.

theless, only in four of the thirty-three metamerically normal worms is it necessary to refer to three segments to indicate spermathecal location, and in two cases all spermathecae are actually in one segment. These results, together with previous findings, show it is unlikely that twenty-two out of twenty-seven specimens of *E. foetida* would have had spermathecae in three segments. Furthermore, the method by which location of spermathecae of the other five specimens was indicated, e. g., "–7–8", as if the first of three pairs[2] had not been found, also supports the interpretation of "normal" that was first suggested above, i. e., presence of three pairs in three consecutive segments[3].

[2] In one case, "–6–7?", in which the question mark seems to indicate uncertainty but as to what, was not explained.

[3] Seminal receptacles cannot be regarded as a *lapsus calami* for seminal vesicles. The latter are four pairs, in ix–xii, in *E. foetida*. Other species may have only three pairs but they are not in three consecutive segments, ix, xi–xii.

Accordingly, it is concluded that Morgan's specimens with spermathecae in two segments were quadrithecal and, as he supposed, *E. foetida*, but that the others were of some sexthecal form with spermathecae in ix, x, xi. Three lumbricid species of this country are so characterized: *Allolobophora chlorotica* (Savigny) 1826 and *Eisenia lönnbergi* (Michaelsen) 1894 with spermathecal pores on 8/9–10/11, *Dendrobaena octaedra* (Savigny) 1826 with the pores on 9/10–11/12. *E. lönnbergi*, though at present within the same genus as *foetida*, has a quite different habitus, is a native of the southern states, has never been reported from the vicinity of the region where the worms in question apparently were secured, has not been found in manure heaps — the source of the material — and is unlikely to have been involved. *A. chlorotica* normally has an obvious yellow or green coloration, as well as other characteristics that would immediately distinguish it at a glance from *foetida*, and has only once been reported from the vicinity of a manure pile. *D. octaedra* does have the same red pigmentation that characterizes *E. foetida*, uniformly distributed (instead of in transverse bands) as in many individuals of *E. foetida*, has been found occasionally in manure piles, and does have much less special glandularity in the region around the male pores (so that site of the male pores would be less easily recognizable). Of the three species, *D. octaedra* is the one most likely to have been inadvertently accepted as *E. foetida*. Nothing, however, has been known of regeneration at levels in front of 15/16 in any species of *Dendrobaena* and *D. octaedra* has not, apparently, been available to others who have studied regeneration in earthworms. An unusually large *octaedra* proportion of the population (in the manure heap that provided the experimental material under consideration) seemingly is indicated by such figures as are available: one of eleven specimens (Table 3, Morgan, 1895), five of sixteen (Table 10), six of eleven (Table 12, first half), four of nine (Table 13), twenty-two of the twenty-seven cases in which spermathecae were mentioned.

The number of records (22) of anterior regeneration that can now be recognized as of *octaedra* is larger than for any other lumbricid (Gates, 1953) except *E. foetida* and two species which have not yet been studied in this country, *Allolobophora terrestris* (Savigny) 1826 and *Lumbricus rubellus* Hoffmeister 1843. These records (Table below) show that head regeneration is possible at each level from 1/2 to 8/9 inclusive. The five segment regenerate shows that equimeric regeneration can be expected at each level from 1/2 to 5/6 inclusive at least.

Failure to secure equimery at levels behind 3/4 indicates that conditions, either of the external or internal environment or both, were less than optimal for regeneration by *octacdra*, as well as for *E. foetida*[4]. The results obtained from four worms that were deliberately cut diagonally instead of transversely (note under table) may indicate that head regeneration is also possible at levels back at least to 12/13.

Table 2

Number of segments in head regenerates of Morgan's sexthecal earthworms

Level of amputation*	Number of segments regenerated				Record quoted from Morgan, 1895, pages
	2	3	4	5	
EL 2/3	1	–	–	–	447
EL 3/4	3	1	–	–	447, 455
EL 4/5	–	2	–	–	448, 456
EL 5/6	–	1	1	–	455
EL 6/7	1	1	1	–	455, 456
EL 7/8	–	1	1	–	456
EL 8/9	1	1	1	1	455, 456

* A symmetrical homoeotic would not have been recognizable after operation.

EL Estimated level. Estimation made, after regeneration and presumably after preservation, from position of male pores and/or location of spermathecae.

When cuts were made diagonally "anterior segments obliquely amputated" (p. 457), four to twelve segments were said to have been completed. In three of these, which had spermathecae after regeneration in "9-10-11" and in which 4, 8, and 12 segments had been "completed", presumably no segments were completely excised. The other specimen had a hypomeric regenerate presumably (indicated by location of the spermathecae in "8-9-10"). All of i–iii was then removed in addition to parts of iv–x ("7 segments completed").

After excision of a piece estimated to comprise 10½ segments, and subsequent regeneration (p. 455), there were still spermathecae in the first two segments of the substrate. The estimate could have been correct, regardless of species, only if the worm involved had been homoeotic (+ 1 or more), or if spermathecae had been developed in the substrate during regeneration. Nothing of the latter sort has ever been recorded from the Lumbricidae.

[4] The number of segments in the head regenerates of *E. foetida* was smaller than has been obtained (Gates, 1949) and in view of this evidence from two different species the less favorable conditions may have been in the external environment.

SUMMARY

Individuals of some sexthecal species were frequently used along with *E. foetida* in Morgan's early studies of earthworm regeneration. From the information available as to distribution, habitat, habitus, etc., of the sexthecal species of this country, it is concluded that only *D. octaedra* is likely to have been inadvertently taken for *E. foetida*. Nothing has been known of anterior regeneration in the genus *Dendrobaena* and the records now attributable to *D. octaedra* show that it is able to develop a head regenerate, in an anterior direction, at each level back to 8/9, possibly to 12/13, and, in better conditions, complete replacement of excised segments may be expected at least at all levels from 5/6 anteriorly.

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CLEMMYDOPSIS BODA A VALID LINEAGE OF EMYDINE TURTLES FROM THE EUROPEAN TERTIARY

BY ERNEST WILLIAMS

In 1847 Hermann von Meyer gave the name *Emys turnauensis* to a small emydine turtle from the Upper (Sarmatian) Miocene of Turnau in Steyermark, Austria. He published no description at that time, but validated the name by a full description and figure in 1858.

Emys turnauensis was founded on an anterior fragment of carapace (nuchal and both first peripherals, second peripheral of the left side, both first pleurals, and parts of left pleurals 2, 3, and 4). Its most evident peculiarity was the absence on the first pleurals of any indication of grooves for the costal scutes. The first vertebral thus extended across the entire front of the shell back of the anterior marginals and the relatively broad nuchal scute. The second and third vertebrals less obviously but unmistakably had a similar great lateral expansion. Von Meyer commented: "Von allen mir bekannten Schildkröten mit Grenzeindrücken zeichnet sich vorliegende durch den Mangel an Seitenschuppen aus. . . . Der Verlauf der Grenzeindrücke sonst ist in dieser Schildkröte so regelmässig dass der Mangel an Seitenschuppen unmöglich für eine zufällige Erscheinung oder für eine Abnormität gehalten werden kann; er wird der Species wirklich zugestanden haben, und es wird sich eigentlich nur um Entscheidung der Frage handeln, ob der gänzliche Mangel einer Schuppenart in einer Schildkröte zur Errichtung eines eigenen Genus brechtigt oder nur zu den Kennzeichen gehört, welche bei der Unterscheidung von Species in Anwendung kommen. Mit der Beantwortung dieser Frage möchte ich um so mehr bis zur Kenntniss der fehlenden Theile der Schildkröte, namentlich des Bauchpanzers zurückhalten, da die hervorgehobene Abweichung im Hautskelet, so auffallend sie ist, mit einer Abweichung in der Zahl oder Form der knöchernen Theile, wenigstens so weit diese verliegen

nicht verbunden sich zeicht; die knöchernen Theile sind vielmehr *Emys* entsprechend gebildet. Zur Errichtung jedoch einer neuen Species war wohl hinreichender Grund vorhanden."

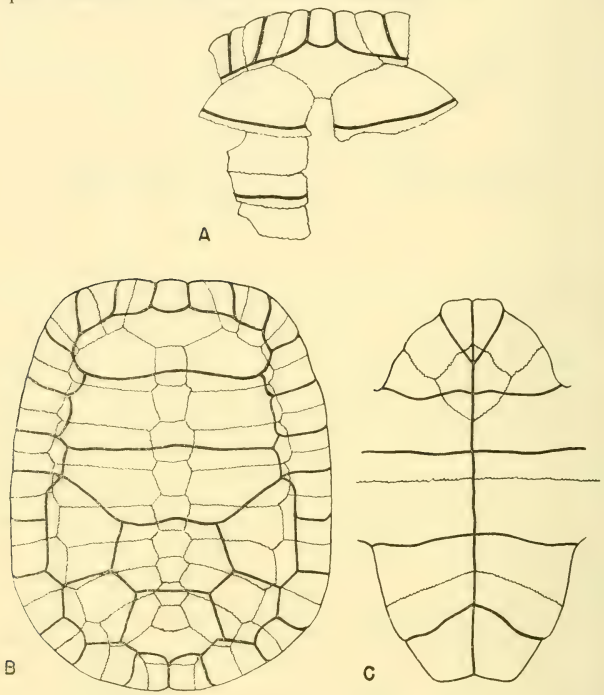

Fig. 1. *Clemmydopsis turnauensis* (von Meyer). A. Type specimen, after v. Meyer. B. Carapace, after Staesche. C. Plastron, after Staesche.

Von Meyer mentioned also that he had an anterior fragment from Tertiary formations at Chaux-de-fonds, Switzerland, which might belong to *Emys turnauensis*, but that he had never seen anything resembling this species elsewhere in Switzerland.

In 1927 Anton Boda described and figured from the Lower Pannonian (Lower Pliocene) beds near Sopron, Hungary, a complete

dorsal shell of a form which he recognized as similar in its vertebral pattern to *Emys turnauensis* but which he referred to a new genus and species as *Clemmydopsis sopronensis*. The new form differed from *Emys turnauensis* in the shape of the neurals. In *Clemmydopsis sopronensis* neurals one to three were hexagonal, short-sided behind, and neural four quadrilateral, while the first neural was oval, the second

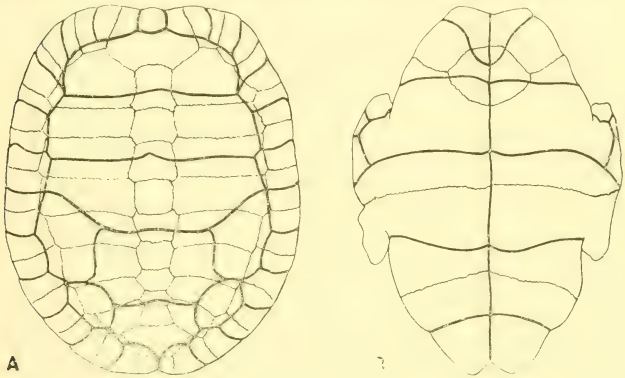

Fig. 2. *Clemmydopsis sopronensis* Boda. A. Type carapace, after Boda. B. Plastron, after Thenius.

to fourth hexagonal, short-sided in front, in *Emys turnauensis*. Boda assigned his new form to the section of the Emydinae which includes *Geoemyda* (*Nicoria* of authors), doing so on the basis of the character of neural shape to which great taxonomic weight had been given by Boulenger, Siebenrock and others.

In 1931, K. Staesche placed on record from the Sarmatian Miocene of Steinheim in Württemberg material very similar to the unique type of *Emys turnauensis* but which he regarded as new, giving it the name *Clemmys steinheimensis*. Staesche's material was much more nearly complete than that of either Boda or von Meyer. He had three specimens, none individually perfect but together providing satisfactory knowledge of both carapace and plastron.

Staesche described his material very fully and discussed the relationship of his species to *Emys turnauensis* and *Clemmydopsis sopronensis*. He admitted the possible synonymy of his species with

Emys turnauensis but considered that one minor difference might be of specific value: the marginal scutes did not encroach upon the first pleural of *turnauensis* as they quite clearly did in *steinheimensis*. He relegated both forms to the genus *Clemmys*, regarding the single point of difference from *Clemmys* as usually understood — the absence of the first and second costals — as of specific value only.

In the case of *Clemmydopsis sopronensis*, Staesche was not in doubt as to the distinctness of the species, but he was quite doubtful of the validity of the new genus. He argued that the difference in neural shape appeared to preclude inclusion of *steinheimensis* in *Clemmydopsis* and that, therefore, if the character of the horny shields was counted of much value, a new genus would need to be erected for *steinheimensis*. He concluded: "Vermutlich dürfte daher wohl auch eine nähere Verwandschaft zwischen *Clemmys* und *Clemmydopsis* bestehen, derart, dasz der Gestalt der Neuralplatten (kurzeste Seiten hinten oder vorn gelegen) keine so überragende systematische Bedeutung zukommen, kann, wie dies Boda nach Siebenrock annimmt. Das Fehlen der 1. und 2. Lateralschilder ist nicht als Genus — sondern nur als Artcharakter zu bewerten. Dieses Merkmal tritt bei zwei verschiedenen (Neuralplatten!) aber wohl verwandten Gattungen an der Wende von Miocän und Pliocän auf, um alsbald wieder zu verschwinden. Man könnte versucht sein in Dacque'schem Sinne von einer Modeströmung zu sprechen, denn ein besonderer Zweck dürfte dieser Einrichtung kaum zugrunde liegen. Mit der Annahme einer näheren Verwand schaft beider Gattungen kann man aber auf diese Deutung verzichten."

In 1934 T. Szalai in a list of the fossil turtles of Hungary synonymized *Clemmydopsis* Boda with *Geoemyda* Gray on the basis of the similar neural shapes, rejecting as not significant at the generic level the peculiarities of the horny shields.

Erich Thenius (1952) has followed Szalai's generic assignment (preferring, however, the synonymous name *Nicoria*) in reporting new finds of *sopronensis* from a new locality Brunn-Vösendorf near Vienna. Thenius' material is important in that it completes our knowledge of *sopronensis* by providing (from dissociated specimens of all the plastral parts) the characters of the plastron, heretofore unknown.

Thanks to the kindness of the authorities of the Staatliche Museum für Naturkünde in Stuttgart and especially to the friendly cooperation and diligence of Dr. Karl Dietrich Adam of that museum I have been able to examine the type specimens of *Clemmys steinheimensis* Staesche. There is little to add to Staesche's accurate description and excellent

photographs. There are, however, some points of interest in regard to the interpretation and systematic position of the fossils.

I wish first to suggest that *steinheimensis* may best be synonymized with *turnauensis*. The two named forms are equivalent in age, not far distant in locality and distinguished by a single quite trivial character which may well be only an individual peculiarity of the unique type of *turnauensis*.

If this synonymy is correct we are dealing then with four occurrences of only two forms. Yet these two forms have received from the very few authors who have written about them four different generic assignments: "*Emys*", "*Clemmydopsis*, new genus", "*Clemmys*", and "*Geoemyda* (= *Nicoria*)".

Of these generic names the first may be dismissed at once; it belongs to a period in which almost all fossil emydine species and even some forms not belonging to the family Testudinidae or the suborder Cryptodira were placed in the genus *Emys*.

More serious discussion must be accorded the other generic assignments, but it appears to me that previous authors have failed to consider one important possibility: that the two forms, which are after all chronologically consecutive, are phyletically related.

The absence of the first two costal scutes in the two forms *turnauensis* and *sopronensis* is a quite extraordinary phenomenon apparently not closely approached by any recorded aberration of the horny shields. The similarities in detail shown by the two forms are fantastically close if they are the result of parallelism only. There is a real difficulty in the plural occurrence of so improbable an event. The difficulty, however, ceases to exist if we assume the event happened only once and if we explain the similarity of the two forms by direct inheritance. The evolutionary and therefore the taxonomic dilemma which the two forms have appeared to present is in all essentials solved by the hypothesis of phyletic relationship.

There are, of course, real differences between the two species, and, in fact, one of the differences — neural shape — has been considered of high taxonomic value and is still used in the taxonomy of Recent forms to discriminate genera.

Without question in the Recent emydine turtles the character of neural shape tends to have utility in segregating natural groups, although not without some instances of difficulty, but, granting to the character the maximum of utility for Recent forms it must still be used with discretion when dealing with fossil forms. It can never be

forgotten that neurals which are hexagonal, short-sided in front, are primitive and that other types have evolved from that condition. Inevitably then some of the ancestors of genera showing the modified types of neurals would be placed — if that character were alone considered — in a more primitive genus. Quite certainly *Geoemyda* and its relatives have evolved from a form with *Clemmys* type neurals. There are indeed a number of examples of evolution in neural shape displayed in the fossil record. The fossil tortoise *Stylemys nebrascensis* of the Oligocene of North America regularly has all the neurals after the first hexagonal short-sided in front: the more highly evolved species of the same genus from the John Day beds (lowest Miocene) regularly have one or more octagonal neurals. *Hadrianus* with primitive neurals evolved into later subgenera of *Testudo* with modified neurals. There is also among Recent forms considerable intraspecific variation in neural shape.

In the present instance *turnauensis* is temporally antecedent to *sopronensis* and in the matter of neural shape structurally more primitive. It is surely a possibility worth attention that the one has a phyletic relationship to the other.

Except for neural shape there are no known differences between *turnauensis* and *sopronensis* which are not at the specific level or below it, and, since none of fossils is quite perfect, it is possible in fact that some of the recorded differences are matters of interpretation and reconstruction and not real. I tabulate the differences below:

turnauensis	*sopronensis*
1. gulars narrow, not overlapping humerals	1. gulars broad, overlapping humerals
2. femoral scutes longer than pectorals	2. pectoral scutes longer than femorals
3. no anal notch	3. a distinct though narrow anal notch
4. first vertebral encroaching on at least the first, second and third peripherals	4. first vertebral encroaching only on the first and second peripherals
5. first neural rectangular-oval, neurals 2–8 hexagonal, short-sided in front, all moderately broad	5. neurals 1–3 hexagonal, short-sided behind, neural 4 quadrilateral, neurals 5–8 hexagonal, short-sided in front, all still broader than in *turnauensis*
6. fifth vertebral and fourth costal moderate in size	6. fifth vertebral and fourth costal quite small relatively to the other scutes

These differences will serve — even if one or two should fail — to distinguish the species.

Now, granting that the two species are directly related, to what genus or to which genera should they be referred?

Admittedly, if the genus *Clemmydopsis* is recognized, it will be solely on the pattern of the vertebrals and costals. It is, of course, possible that some of the skeletal parts which are not known — skulls, limbs, or vertebrae — might show striking differences from the related forms, *Geoemyda* or *Clemmys*, but this is an untestable hypothesis, which it is useless to consider. The question is then a simple one: Is a single character — at once striking and superficial — adequate for generic distinction?

There is unfortunately no objective way to evaluate such a question. Characters involving quite radical differences are in some cases infraspecific, while other characters which to the non-specialist are utterly trivial separate suprageneric groups. That the rank of supraspecific categories is wholly subjective or nearly so is a point generally agreed upon. In practice it is necessary to steer a middle course between those who would reduce genera arbitrarily on mnemonic grounds — deploring the necessity of remembering so many names — and those who tend to regard as generic any differences which are recognizable immediately and as specific any differences which are determinable with more difficulty.

In the present case there are several grounds for accepting — at least for the present — *Clemmydopsis* as a valid genus.

1. The peculiar modification of the horny scutes, though a single character, is also one without parallel in the normal characters or the known variants of the chelonian order. Anomalies of the plates and scutes of turtles have been studied intensively by Gadow, Newman, Coker, Grant, Lynn and others using literally many hundreds of specimens, yet nowhere does there appear to be any record of a scute anomaly resembling that seen in these forms from the Miocene and Pliocene of central Europe. The closest parallel is with two cases cited by Grant, one in *Testudo denticulata* and one in *Chrysemys picta* in which the vertebrals do touch the marginals. But even here the similarity is verbal only, the marginals being enlarged and not the vertebrals while the grossest asymmetries and distortions indicate the abnormality of the condition.

2. There is currently recognized a Recent genus *Notochelys* with the single species *N. platynota* which differs from *Clemmys* primarily by

the intercalation of a small scute between the usual fourth and fifth vertebrals. But this condition, while a population character in *platynota*, is a rather common variant in numbers of other members of the Testudinidae. This variation is especially common in *Homopus* in which a very substantial fraction of at least *H. areolatus* shows a similar condition Thus while there is a weak argument for *Clemmydopsis* on the grounds of symmetry in generic discrimination, it may in this case be countered by a demand for suppression of the generic separation for *N. platynota*, which, while certainly a distinct species, does not obviously merit more than subgeneric distinction.

3. However, the best ground for separating *Clemmydopsis* as a genus is the impossibility of placing the two central European forms, directly related though they seem to be, in any one currently recognized genus. On the current definitions of emydine genera the Miocene form belongs in *Clemmys*, where Staesche has already placed it, and the Pliocene form in *Geoemyda* (= *Nicoria*) to which Szalai and Thenius have already referred it. This, however, is an inadmissible solution since it would make the genus *Geoemyda* polyphyletic.

It is entirely possible, indeed probable, that *Clemmys* and *Geoemyda* as at present defined are mere form genera, but the true relationships within the *Clemmys-Geoemyda* section of the Emydinae are still to be analyzed and promise to be difficult of analysis. Thus while it is perhaps possible to look forward to a time when relationships will become known, and larger genera may be recognizable within the Emydinae, it is not now desirable to randomly unite emydine genera, in so doing pretending to a knowledge which is not at hand. Rather it is preferable to split rather finely at the moment, counting the present as that period of analysis which must precede a synthesis.

We need first to discover the correct phyletic sequences. We must first recognize the family tree; afterward we may dispute the nomenclatorial rank of the several twigs and branches.

Clemmydopsis Boda should then be retained at present for an apparently short-lived but uniquely specialized lineage of emydine turtles from the later Tertiary of middle Europe. Whether or not it should ultimately be retained as a genus in formal nomenclature, it is certainly a "gens" in the sense of Vaughan 1905 (in Cain 1952) (a lineage or phyletic line).

Examination of the type of *Clemmys steinheimensis* in Stuttgart was made possible by the support afforded by a Guggenheim fellowship 1952–1953.

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ABSENCE OF MESOPLASTRA IN A *PELOMEDUSA* (TESTUDINES, PELOMEDUSIDAE)

BY ERNEST WILLIAMS

Mesoplastra (a pair of bones intercalated between hyo- and hypoplastra) are believed to be primitive features in turtles. They were often present in Jurassic and Cretaceous genera, and two pairs of mesoplastra were reported by Fraas (1913) in *Proterochersis*, one of the Triassic genera. Mesoplastra have, however, been lost several times independently: (1) in the Jurassic and Cretaceous plesiochelyids and thalassemydids; (2) in Wealden *Chitracephalus*; (3) in all cryptodires; (4) in the chelids among pleurodires. In many of the groups in which they are known, they were early reduced. Primitively they extend quite across the plastron and meet centrally. In some Pleurosternidae, however — *Platychelys* — and in some Baenidae (within the genus *Baëna*, cf. *Baëna riparia*, Hay, 1908) they fail to meet in the center.

To my knowledge, however, no instance has been recorded previously of the complete absence of mesoplastra in any form in which they were typically present. Such an example is now furnished by a specimen of *Pelomedusa subrufa* from Uganda, collected by Delme Radcliffe and now 1905-5-19-1 in the collections of the Reptile Section, British Museum (Natural History).

In *Pelomedusa* the mesoplastra are typically small and lateral. In BM 1905-5-19-1, however, no mesoplastra are visible, and instead the hyo- and hypo-plastra join for their full transverse extent and do so quite symmetrically on the two sides just as in the Chelidae or the Cryptodira. The carapace again joins the plastron perfectly without affording any place for a trace or rudiment of mesoplastra.

Yet this specimen is clearly referable on "habituellen Merkmalen" to the family Pelomedusidae, the genus *Pelomedusa*, the species *subrufa* (the single species of the genus).

The carapace is quite normal except for some minor asymmetries and the fusion of vertebrals 3 and 4 to a single scute. The nuchal scute is, as usual, absent. The first neural is rather characteristically tapered in front. In normal fashion there are 7 neurals, and the posterior pleurals meet behind the neurals separating them from the suprapygal. In contrast to chelids the posterior peripherals are all rather narrow and show no suggestion of posterolateral expansion.

The plastron is quite typical of the genus in the size and relations of its horny scutes. There is the usual median fontanelle, though it is small in this instance, as seems frequently to be the case in northern representatives of the genus and species.

The skull is quite characteristically pelomedusid and very unchelid in the temporal emargination from behind and in the marked projection of the opisthotic posterior to the squamosal.

All these features and the lack of mesoplastra are well shown in the excellent photographs (Plates 1 and 2) taken by Peter Green of the photographic staff of the British Museum (Natural History) and reproduced by permission of the Trustees of that institution.

The absence of mesoplastra is quite certainly an individual variation. Four specimens from Mt. Elgon, Uganda, otherwise very similar to the individual without mesoplastra, all show these elements well-developed and only slightly varying in size. All resemble the aberrant specimen in the reduction of the median fontanelle of the plastron: one, indeed, has the fontanelle completely closed.

The presence of mesoplastra is supposedly a family character of the Pelomedusidae, but except in the genus *Pelusios* the mesoplastra are always small and lateral, in effect vestigial, and the disappearance by individual variation of a vestigial feature is not too surprising.

It is, however, of special interest in connection with the suggestion recently made by me that the genus *Pelusios* with well-developed mesoplastra (meeting medially) has been derived directly from the genus *Pelomedusa* with reduced mesoplastra by a secondary expansion of these elements. If this suggestion be valid, then, taken in connection with the present case, we see in *Pelomedusa* an interesting ambivalence of evolutionary potentiality, one type of variation reversing a previously well-defined trend to restore (with some differences) an ancestral condition and, on the other hand, the opposite type of variation

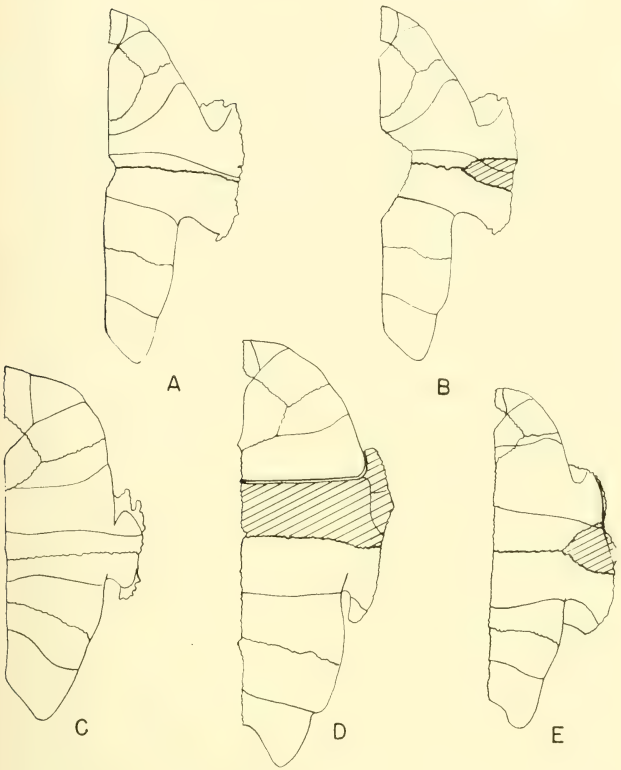

Figure 1. Plastra of various turtles to show presence or absence of mesoplastra. Mesoplastra shaded. A. *Pelomedusa* without mesoplastra. B. Normal *Pelomedusa*. C. a chelyid (*Hydromedusa*). D. *Pelusios*. E. *Podocnemis*. (B to E after Boulenger.)

carrying to completion the former trend and realizing a more modernized type of shell.

It does not seem advisable on the basis of a single, probably rare, variation to revise the definition of the family Pelomedusidae to include forms without mesoplastra. Such a variation would appear — on the face of the present evidence — to have as little taxonomic weight as the occasional men born without legs have for the definition of the family Hominidae.

Yet there is this difference: a man without legs is not likely to be a selectively valuable variant, but, as the majority of the living forms testify, a turtle without mesoplastra is not only perfectly viable but highly successful. It cannot be assumed, therefore — given a forward-looking evolutionary point of view — that the pelomedusids will always and in all cases be forms possessing mesoplastra.

There is indeed a special caution pertinent for paleontologists. If the present specimen had been found as a fossil, it would almost certainly have been misallocated as to family. There is in fact no assurance — the pelomedusids having once been world-wide — that all past species have always had mesoplastra. The use of key characters in identification without regard to total habitus and neglecting the ever surprising power of animals to vary and to undergo evolutionary change will only lead to error.

The observations recorded here were made during a visit to the European collections, made possible by a Fellowship from the Guggenheim Foundation. Access to the specimens mentioned was generously granted by Dr. H. W. Parker, Keeper of Zoology, British Museum (Natural History), and assistance was given by Mr. J. C. Battersby and Miss A. G. G. Grandison of the Reptile Section.

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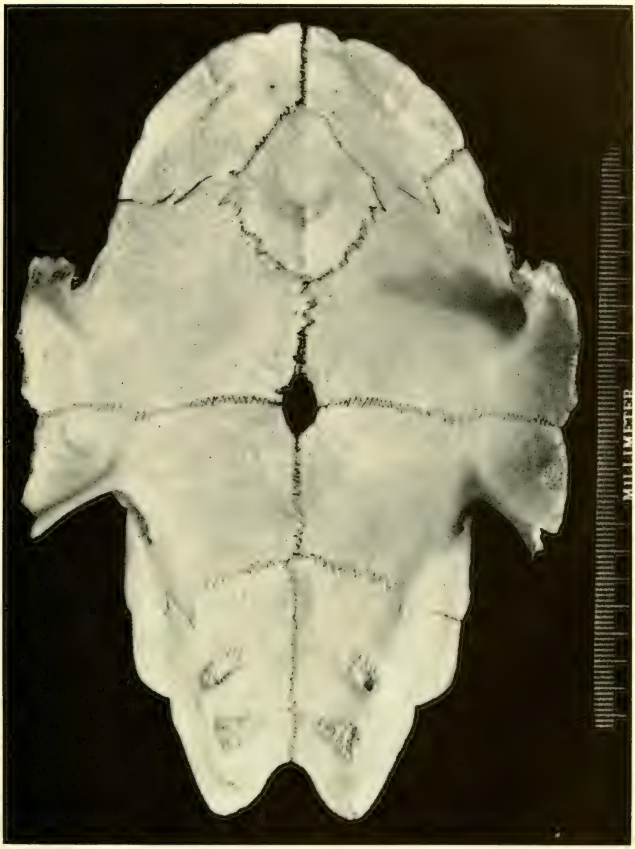

PLATE 1

Pelomedusa subrufa B.M. N.H. No. 1905-5-19-1. Internal view of plastron.

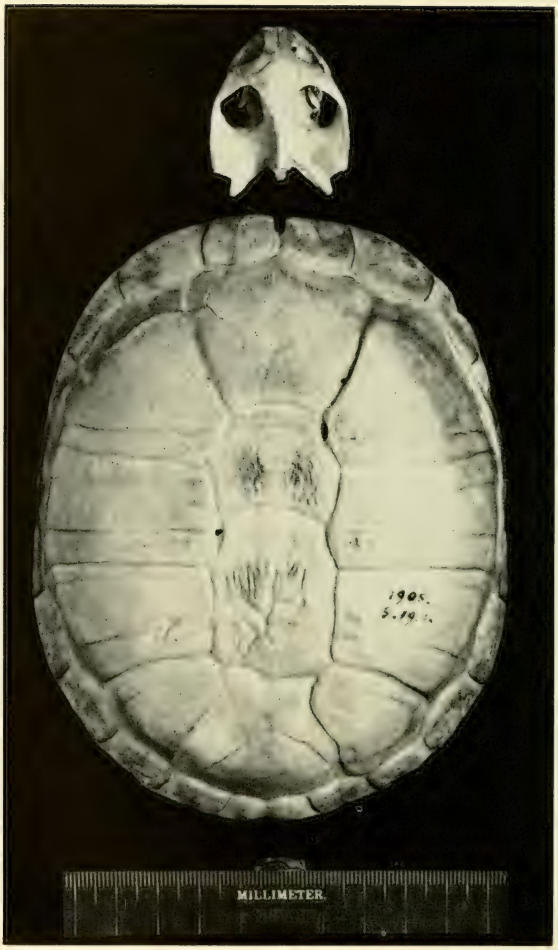

PLATE 2

Pelomedusa subrufa B.M.N.H. No. 1905-5-19-1. Dorsal view of skull and shell.

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AESTIVATION IN A PERMIAN LUNGFISH

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It is generally recognized that the survival to modern times of the three living genera of dipnoan fishes — *Epiceratodus* (*Neoceratodus*) of Australia, *Protopterus* of Africa and *Lepidosiren* of South America is due in great measure to adaptations which tide them over the seasonal droughts characteristic of the tropical regions which they inhabit. A primary adaptation lies in their possession of functional lungs which enable them to utilize atmospheric oxygen, supplementing the reduced oxygen content in stagnant waters during drought; indeed, in *Protopterus*, the lung-breathing function has attained such dominance that the fish is unable to survive if air-breathing is not possible.

But air-breathing in itself is not entirely satisfactory as a means of drought survival — particularly if, as may often happen, the stream or pond dries up entirely. The Australian lungfish, under such circumstances, may wallow into the mud, and have some chance of escaping desiccation or enemies. In the African and South American forms, an additional adaptation is present — the development of a technique of aestivation. Members of these genera are rather elongate and eel-like in shape, in contrast to *Epiceratodus* and to primitive lungfishes. On the approach of the dry season the fish burrows in coiled form into the mud, which hardens about it to form a cocoon; an opening from the surface allows the entrance of air, but the amount needed is small, due to a great reduction of metabolic processes. The fish passes into a "summer sleep" comparable in great measure to the hibernation of various northern animals — a phase which ends with the return of the water and the resumption of normal aquatic life.

Nothing has been known until now of the origin of lungfish aestivation. The early lungfishes, as far as known, all had a fusiform body shape fairly comparable to that of the modern *Epiceratodus*, and hence were incapable of coiling in a burrow in the fashion of the elongate-bodied *Lepidosiren* or *Protopterus;* but it is possible that burrowing of some sort accompanied by physiological features of aestivation, might have preceded change in body shape. The lungfish *Gnathorhiza*, characteristic of the Clear Fork Permian of Texas, has been suspected by both the present writers to be related to the *Lepidosiren-Protopterus* group (Romer and Smith 1934, Olson 1951) but there is no strong proof of relationship, and the body structure was unknown.

Some years ago Dr. H. J. Sawin and Mr. Adolph Witte, while engaged in work for the Texas Bureau of Economic Geology were told by a resident of Willbarger County, of a geologic occurrence which local geologists had been unable to interpret. They visited the locality, made collections of the material for the Bureau and informed others, including the present writers, of the incident. In 1952 Mr. Witte took a Harvard field party, including the senior author, to the site; observations and collections were made at that time and on a return visit the following spring.

The locality lies in southern Willbarger County, Texas, on the Reed Ranch, in Section 34, Block 3, H. & T. C. RR., Co. Survey. The area has not been mapped in detail geologically but the horizon appears to be a short distance above the Lueders limestones and hence in the lower part of the Arroyo Formation of the Clear Fork Group, Lower Permian. Gently sloping exposures here run for a hundred yards or so close to the south bank of Minnie's Creek. Between two thin impure limestones lies a bed of red shale. Scattered over the surface are numerous circular discs, somewhat like large checkers, with diameters which are for the most part between 5.5 and 10 cm. The material of the discs is essentially the same as that of the shale bed from which they are derived, but is slightly harder and somewhat more calcareous, so that they tend to weather out of their enclosing matrix. On excavation, these discs are seen to be segments cleaved from vertical cylinders which are thickly spread through the shale, often only a few inches apart. In no case was a complete cylinder seen; the greatest length preserved in a specimen excavated and collected was 28 cm. The cylinders, in general, weather out from the softer shales with a smooth surface; in some instances portions of the surface show slickensides. No upper terminal portions were found; apparently, at the top,

the material of the cylinder blends laterally with the superposed calcareous shale. The lower ends of the cylinders are generally smoothly rounded; in some cases, however, a lower terminal portion has a diameter rather less than the major portion of the "bore".

The great majority of the "checkers" fractured off from the cylinders show no organic material on their surfaces. A fair number, however, show fish remains. In some instances these appear to be scales and other disarticulated elements of small palaeoniscoids Most of the remains, however, are clearly dipnoan in nature. The hardness of the shale and the relatively soft nature of the bone makes preparation difficult, and reliance has been had mainly on the structures seen in section on the disc surfaces or, in some cases, weathering of the external surface of the cylinders. Bony scales and plates are frequently seen in section and in a few specimens fracture has shown scales in surface view, the largest about 20 mm. in greatest diameter. Numerous discs show hollow ribs, neural or haemal arches and fin supports, sometimes in articulated series. Preparation of the basal segment of one of the cylinders (figured) has revealed a considerable portion of a caudal fin of the sort typical of Paleozoic dipnoans. Vertebral arches and fin elements are present, partly as bone, partly preserved as impressions. The vertebral axis, presumably cartilaginous in life, is represented by a vertically oriented band devoid of impressions. The end of the tail, poorly preserved, was curved around the bottom of the cylinder.

While much of the lungfish material suggests a considerable degree of decay and maceration, it seems certain that in many instances we are dealing with cross-sections of complete, or nearly complete lungfish bodies. In a few instances where "articulating" discs composing the greater part of a cylinder have been collected, it is obvious that we are dealing with successive sections of a single fish, larger, frequently rounded, body sections in the upper and middle parts of the series and caudal sections, typically lens shaped, at the lower end. In many cases the internal skeletal materials are rather irregularly scattered across the surface of the section; in others the arrangement of the ribs and fin supports is essentially regular, and toward the disc margins there can be made out body outlines, marked by scale sections with a surrounding layer of darker matrix.

The only lungfishes known from the Clear Fork belong to the genus *Gnathorhiza*, mentioned above; *Sagenodus*, the common Pennsylvanian genus, possibly antecedent to *Ceratodus* and *Epiceratodus*, is not

recorded in Texas above the Wichita group. But while it is probable that the Reed Ranch lungfish is *Gnathorhiza*, no tooth plates have been found there to make identification certain. A second find, however, has produced a number of fragmentary teeth. These are unmistakably the blade-like, shearing teeth of *Gnathorhiza* and are referable to the species *G. dikeloda* rather than *G. serrata*. This locality was discovered by the junior author and Dr. Nicholas Hotton III in 1949 and has been revisited several times since then. The bed in which the cylinders occur is located in north central Knox County, Texas, on the Waggoner ranch. It crops out along a small tributary to Little Mustang Creek in locality K1 of the junior author (see Olson, 1951 p. 104). The age is middle Vale of the Clear Fork Group, Lower Permian. The site is approximately 700 to 800 feet higher in the Clear Fork section than the Reed Ranch locality.

The physical features of the cylinders from the two sites differ in no important particulars. Those from the Vale locality occur in a deep red shale which varies in thickness from two to three feet. Above and below this bed are lighter colored shales that appear to have been deposited under somewhat different conditions. The shale is best exposed along a small arroyo, but crops out sporadically over an area of about an acre. The cylinders are distributed in rather irregular groups of ten to twenty in unevenly spaced areas not much more than a yard square. The longest cylinder encountered measured 45 cm., but as in the case of the Arroyo specimens no upper termination has been identified. The vertical orientation shown in the specimen figured is constant throughout the deposit.

Organic remains in the cylinders from the two localities differ somewhat. The most common remains in the Vale cylinders are ribs, skull plates and scales of *Gnathorhiza* but, although the ribs in some instances suggest the general body shape of the fish, no case in which the scales show the body outline has been observed. As at the Reed Ranch locality, remains of lungfish are found only in a fraction of the cylinders. Scales of small palaeoniscids and infrequent scraps of skulls of some small captorhinid reptile occur in others. More abundant, however, are partial vertebral columns and single vertebrae of the small, worm-like amphibian, *Lysorophus*. In no case have these columns been found in the coiled condition characteristic of *Lysorophus* specimens throughout the Arroyo formation.

There can hardly be any question that the lungfishes from the two localities belong to the same genus. Some question does exist, how-

ever, with respect to specific identity. Two species, *G. serrata* and *G. dikeloda*, are known from the Vale formation, but only the first has been found in the Arroyo (Olson, 1951). Tooth plates of *G. serrata* are small, lower plates ranging from 10 to 12 mm. in length, whereas those of *G. dikeloda* are between 25 and 32 mm. long. The skulls of adult individuals of *G. dikeloda* appear to have been between 75 and 100 mm. long; this would suggest that the skulls of *G. serrata*, unknown as yet, would have a range of between 25 and 35 mm. The fact that the Arroyo and Vale cylinders are comparable in size indicates that they were made by fish of about the same dimensions. There is, however, the puzzling fact that no teeth of the larger species have been found in the Arroyo in spite of very extensive exploration of its exposures. Except at the Reed Ranch locality lungfish remains are exceedingly rare in the Arroyo; only four or five occurrences have been reported, and these have consisted of single teeth. It may well be that *G. dikeloda* was in existence during the Arroyo times, but that it found suitable habitat in few localities in the areas which are now exposed. With increasing aridity during the Vale, the number of habitats and the chance of discovery probably were greatly increased.

From the data given above, the nature of the phenomena described will be as obvious to the reader as to the authors. We are here surely dealing with evidence of aestivation of lungfish at an early, Paleozoic stage in the history of the Dipnoi. The cylinders are aestivating burrows, made by lungfishes in the muddy bottoms of drying lakes or streams. That most of the cylinders are empty is to be expected; most of the fishes which occupied them survived to the return of the waters and swam away. The burrows were later filled by sediments fairly similar to those which had already formed the mud banks into which they had burrowed. Fortunately, however, the filling material at the localities described was of a somewhat harder, more calcareous, nature than that of the original mud; had they been just the same, differential weathering would not have occurred and the burrows would probably have escaped observation. The lack of definite upper "openings" of the burrows is presumably due to the disturbance of surface materials on the return of the water. The presence of lungfish remains in some of the cylinders indicates that a certain percentage of the aestivating population failed to survive until the return of the waters. The finding of occasional actinopterygian remains in the burrows is due to the presence of palaeoniscid minnows in the returning waters before the burrows had been filled by sediments. This probably applies to the

remains of *Lysorophus* as well. This amphibian, like *Gnathorhiza*, had both aestivating and free swimming phases. It characteristically was coiled during aestivation. The fact that coiling has not been observed in the burrows indicates that *Lysorophus* entered the open holes left by the lungfish upon the return of the water, and died during the non-aestivating phase of their existence.

The finding of *Gnathorhiza* teeth in the material from the Vale (KI) locality, together with the absence of identifiable remains of any other lungfish type in the Clear Fork beds makes it seemingly certain that the burrows were made by that lungfish and that alone. This evidence of the adoption of aestivating habits by *Gnathorhiza* strengthens the suggestion, gained from tooth plates and skull pattern, that this genus is possibly ancestral to the modern aestivators, *Lepidosiren* and *Protopterus*. One major difference in the mode of aestivation between modern forms and *Gnathorhiza* may, however, be noted. The Recent genera are elongate, eel-like animals which coil their bodies in a flask-shaped burrow. There has been no previous evidence of body shape in *Gnathorhiza*. The Permiam burrows may be somewhat narrower in their upper portions; they are, however, essentially cylinders rather than "flasks", and in no case is there evidence of more than one section through a fish body at a given level of a burrow. It thus seems certain that the *Gnathorhiza* body was of a normal, non-elongate fusiform shape; that the burrow was formed by a spiral rotation of the body and tail with the fish's long axis in a vertical position; and that the aestivating fish was posed erect in the burrow, essentially "standing on its tail" with the mouth at the top, close to the surface where air was available.

EXPLANATION OF PLATE

Above, a series of exposed burrows at the Reed Ranch locality; a half-dollar gives an indication of size. *Center*, a terminal section of a burrow developed to show an included lungfish tail, its tip curved upward. The skeleton is partly preserved in bone, partly as impressions which have been painted white. At the left, a lateral view of the specimen; at the right, a view from the underside. *Below, left*, a burrow in place at the KI locality; length 45 cm. *Below, right*, an incomplete burrow from the Reed Ranch locality; length 25 cm.

The genus *Gnathorhiza* is known not only from the Texas beds, but also from the late Pennsylvanian of Illinois. In Texas, however, it is very rare in the Wichita formations of the Permian where *Sagenodus*, common in the Pennsylvanian, is fairly abundant: on the other hand, there is no trace of *Sagenodus* in the Clear Fork, where *Gnathorhiza* replaces it. This local succession is in agreement with our beliefs as to the climate of early Texas. Various lines of evidence suggest that Clear Fork time, particularly that of deposition of the Vale and Choza of that group, was one of increasing aridity with marked seasonal variations in rainfall (*cf.* for example Olson, 1948). Accompanying this change is a shift in the local dipnoan fauna from *Sagenodus*, a presumed non-aestivating form, to *Gnathorhiza*, better adapted for survival under drought conditions.

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BREVIORA

Museum of Comparative Zoology

CAMBRIDGE, MASS. MARCH 3, 1954 NUMBER 31

NEW FRESHWATER GASTROPOD MOLLUSKS OF THE AFRICAN GENUS *LANISTES*

BY T. PAIN

London, England

The two new species and one subspecies described herein form part of the collection of the Museum of Comparative Zoology at Harvard College. I am deeply indebted to Dr. J. C. Bequaert and Dr. W. J. Clench for the opportunity to examine and describe them.

LANISTES (LANISTES) KOBELTI, new species

Figures 3–4

1913. *Lanistes* sp.? Kobelt, Mon. Amp. in Martini and Chemnitz, Syst. Conch. Cab., 1, Abt. 20, Neue Folge, pl. 30, figs. 4–4a.

Shell sinistral, fairly thin. Whorls strongly shouldered below the suture, with a very slight ridge. Spire produced, apex much corroded. Aperture ovate; parietal lip simple and only thinly calloused; columella thin, not reflected. Umbilicus very wide and deep, limited behind by a very prominent, angular, thickened ridge, which forms a slight angle at the base of the moderately concave columella. Growth-lines irregular, interspaced with fine axial striae, and cut by very fine, irregular, close-set spiral engraved lines in the holotype (very superficial in the paratype). Color pale yellowish-brown, with numerous irregularly spaced reddish-brown bands; interior of aperture pale bluish-white banded with reddish-brown. Operculum corneous, of the usual shape.

Measurements (in millimeters)

	Length	Width	Aperture Length	Aperture Width	
Holotype	23	24	15	11	Fig. 3
Paratype	23	23	15	11	Fig. 4
"	18	23	15	10	

Locality. "Africa" (probably West Africa); holotype M.C.Z. No. 173419; paratypes M.C.Z. No. 173420 and in T. Pain Coll.

This unusual little species was apparently figured by Kobelt (1913, pl. 30), but he did not name it or mention it in the text. The umbilical keel is very prominent, more so than in *L.* (*L.*) *congicus* Boettger. The spire is also higher and the suture less flattened than in that species. *L.* (*L.*) *kobelti* is, as the above table shows, very constant in size and subject to but little variation in this respect.

Lanistes (meladomus) connollyi, new species
Figures 1–2

Shell sinistral, perforate, fairly solid. Color dark reddish-brown, without external bands. Whorls noticeably flattened and obtusely shouldered above, rounded below, with a blunt angulation around the umbilicus which is deep and moderately wide. Apex entirely corroded, remaining whorls 3. Surface somewhat malleated, with fine and regular growth-lines; spiral sculpture obsolete. Aperture ovate vertical; lip simple, thin, edged with pale blue. Columella thin, evenly curved, not angular at the base. Parietal lip bluish-white and only thinly calloused. Color dark reddish-brown, without external bands; interior of the aperture marked with faint reddish-brown lines. Operculum unknown.

Measurements (in millimeters)

	Length	Width	Aperture		
			Length	Width	
Holotype	40	36	31	22	Fig. 2
Paratype	45	40	32.5	26	Fig. 1
"	43	39	30.5	24.5	
"	55	50	38.5	30	
"	45	44	33	27.5	

Localities. Southern Rhodesia: Victoria Falls, holotype *ex* Connolly Coll., M.C.Z. No. 173421, and paratypes, M.C.Z. Nos. 173422 and 179845; also at Congo Museum, Tervuren, and in T. Pain Coll. Northern Rhodesia: River Kafue at N'kana, near the Congo border, paratype, collected by C. von Hirschberg, M.C.Z. No. 173423.

Additional specimens of this species, referred to *Lanistes ellipticus* von Martens by the late Major Connolly, are from the mouth of the Chobe River, Southern Rhodesia (Holub) and from the Kafue River, Mumbwa District, Northern Rhodesia (Pitman). (See Connolly, M.,

1938, Ann. South African Mus., 33, p. 556.)

L. connollyi is easily confused with *L. ellipticus* v. Martens, which occurs in the same general territory. It differs in its less upright elliptical form, decidedly shouldered whorls more or less flattened below the sutures, the deeper and wider umbilicus and the pronounced blunt angulation around the umbilicus.

Lanistes (meladomus) ovum mweruensis, new subspecies
Figures 5–7

Shell small, fairly thick. Color uniform greenish-brown, without trace of bands. The spire is much corroded; remaining whorls 3, rapidly increasing, the last considerably inflated. Sutures impressed, but little flattened. Umbilicus narrow but deep. Surface with fairly prominent growth lines, interspaced with fine wavy striae, especially on the body-whorl. Aperture ovate, lip simple, interior pale blue. Columella thin, curved, joined by a moderately thick callus of bluish-white color. Operculum as in typical *L. (M.) ovum*.

Measurements (in millimeters)

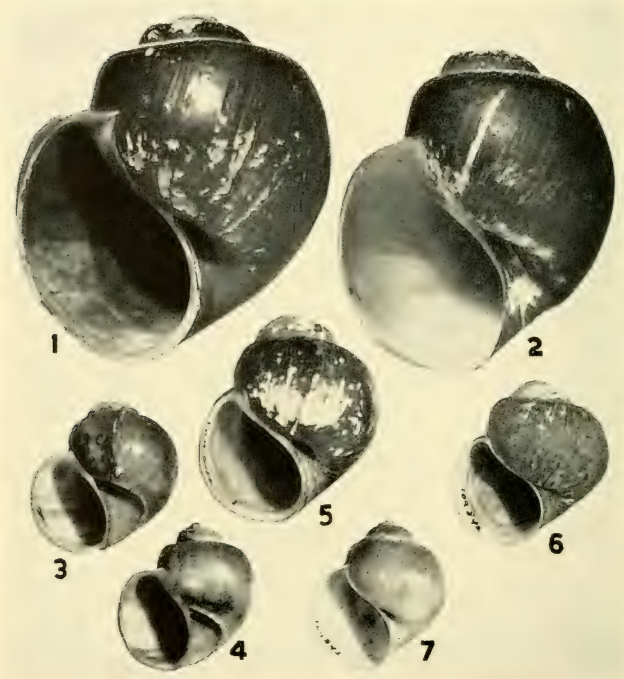
	Length	Width	Aperture		
			Length	Width	
Holotype	30	30	19.5	16	Fig. 5
Paratype	30	32	21	15	Fig. 6
"	26	25	19	13.5	Fig. 7

Localities. Belgian Congo: Lake Mweru (or Moero) at Kilwa, holotype, collected by Dr. L. van den Berghe, M.C.Z. No. 109842, and paratypes, M.C.Z. No. 185683; also at Congo Museum, Tervuren, and in T. Pain Coll.; Lake Mweru at Katenge near Kilwa, paratypes, M.C.Z. No. 152483 (received from Dr. M. Wanson); Lake Mweru at Pweto, paratypes, M.C.Z. No. 152346 (received from Dr. M. Wanson); Lake Mweru at Moba (Chamfubu River) near Pweto, M.C.Z. No. 185682 (received from Dr. M. Wanson).

Only the holotype (Fig. 5) and one of the paratypes (Fig. 6), both from Kilwa, appear to be full-grown. The paratype in Figure 7, also from Kilwa, is immature. Most of the other paratypes are even younger, the smallest being only 9 mm. in length

Apparently a dwarf race of *L. (M.) ovum* Peters, possibly confined to Lake Mweru. When adult it resembles the much larger *L. (M.) ovum procerus* v. Martens, but has always a much thicker and more solid shell. Immature shells are always of a uniform olive-green color

often with traces of malleation on the body-whorl. So far as known, *Lanistes ovum* is the only species of the genus recorded from Lake Mweru, where it is said to live in the swamps near the coast.



Figs. 1–2, *Lanistes* (*Meladomus*) *connollyi*, new species: 1, paratype, N'kana; 2, holotype, Victoria Falls. Figs. 3–4, *Lanistes* (*Lanistes*) *kobelti*, new species, Africa: 3, holotype; 4, paratype. Figs. 5–7, *Lanistes* (*Meladomus*) *ovum mweruensis*, new subspecies, Kilwa: 5, holotype; 6 and 7, paratypes. All figures slightly over natural size.

BREVIORA

Museum of Comparative Zoology

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FOSSILS AND THE DISTRIBUTION OF CHELYID TURTLES

2. Additional Reputed Chelyid Turtles on Northern Continents:

Palaeaspis conybearii (Owen) — a Pelomedusid.

BY ERNEST WILLIAMS

In the previous paper of this series a re-examination of the description of "*Testudo*" *leithii* Carter from the Eocene of India demonstrated that this fossil, so long considered a chelyid, belongs instead to the related but quite different family Pelomedusidae.

The family Chelyidae of side-necked turtles (Pleurodira) is at present restricted to South America east of the Andes, and to the Australian region. The Indian fossil was one of several forms which were thought to complete the discontinuous distribution of the family by showing its former presence outside the Recent range of the family. The present paper discusses another of these forms. I am deliberately including every case known to me which has been seriously proposed since the modern conception of the Chelyidae arose.

In 1870 the genus *Palaeaspis* was proposed by Gray for *Emys conybearii* Owen, a fossil turtle from the London Clay Eocene. This generic name has been ignored by all subsequent authors. Gray placed his new genus in the Chelyidae next to the genus *Hydromedusa* with the following generic definition: "Shell depressed; nuchal shield large and quadrangular, included within the anterior marginal shield. First vertebral shield very small, oblong and transverse, at hinder base of nuchal: second and third vertebral hexangular, as long as broad. Sternum broad, truncated in front and notched behind, transversely concave in the middle and bent up at the ends."

Examination of the type specimen of *Emys conybearii* Owen (B.M.N.H. 39449) at the British Museum reveals that Gray's interpre-

tation of the dorsal shields is a perfectly possible one (Fig. 1). The first shield behind the first marginals, which meet in the mid-line, is divided transversely and on the analogy of *Hydromedusa* could be interpreted as a nuchal succeeded by a small first vertebral. This

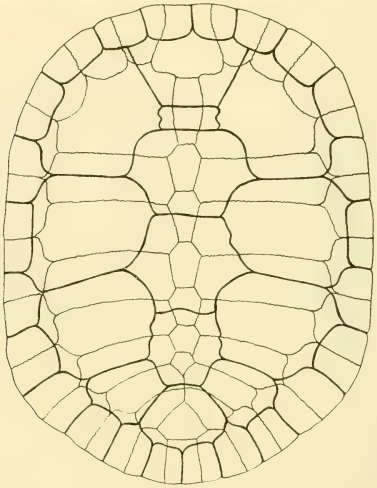

Fig. 1. *Emys conybearii* Owen. Dorsal view of type shell (after Owen). 1/6 natural size.

transverse division of the first median shield has been ignored in later references to *Emys conybearii*, although it was mentioned and discussed by Owen in the original description and was clearly shown by him in his plate XXVIIIA, which is a much restored but essentially accurate representation of the specimen.

E. conybearii Owen was synonymized by Lydekker and Boulenger (1887) with the earlier named *Emys delabechei* Bell, probably justly, but the latter name was based upon an imperfect shell which does not show the region which is critical in *E. conybearii*. With the example of *Hydromedusa* in mind, it is not possible without further evidence to dismiss the condition shown in *E. conybearii* as an individual variation. Further, since the bony areas under the first vertebral are

unusually elongate (as in chelyids and *Pelusios*), the first neural especially being very elongate, there is greater probability of an unusual condition of the horny scutes. *Palaeaspis* is probably a valid genus.

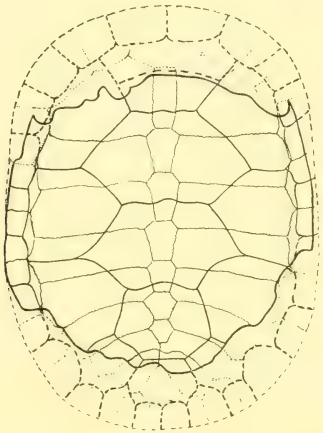

Fig. 2. *Emys laevis* Bell. Dorsal view of type shell (after Owen and Bell, reconstructed). 1/3 natural size.

Fortunately, as Lydekker and Boulenger were able to state, further preparation of the type of *E. conybearii* after Owen's description of it revealed the presence of small lateral mesoplastral bones as in *Podocnemis* and *Pelomedusa*. The existence of these bones I have been able to verify on the type specimen. The form is therefore a pelomedusid, not a chelyid.

The case of *Palaeaspis* is instructive. On the characters of the dorsal shell it was entirely plausible for Gray to place this form as a chelyid. The only other known example of a transversely divided first vertebral[1] occurs in a chelyid genus. The elongation of the first vertebral and of that region of the bony shell is rather characteristically chelyid (though occurring also in *Pelusios*). If it were not for

[1] I prefer to interpret the situation in both *Hydromedusa* and *Palaeaspis* in this rather than in the conventional fashion.

the later discovered typically pelomedusine mesoplastra, this genus would still be regarded as chelyid and thus would, it seems likely, be used as such in zoogeographical speculation. *Palaeaspis* may thus serve as a special caution against the use of imperfect fossils as critical zoogeographical data.

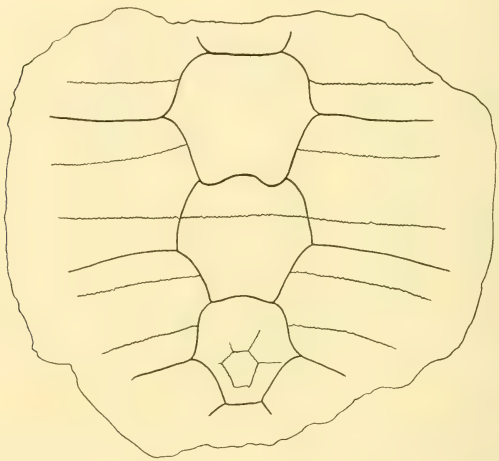

Fig. 3. *Emys delabechei* Bell. Dorsal view of type shell (after Owen and Bell). 1/5 natural size.

Comparison of the types of *Emys conybearii* Owen, *Emys laevis* Bell (B.M.N.H. 37209) (Fig. 2), *Emys delabechei* Bell (Geological Survey of Great Britain No. 6634) (Fig. 3), and a comparison of these with the figure of *Platemys bowerbanki* Owen (Fig. 4) (the type of which appears to be lost) leads to the belief that all the pelomedusids of the London Clay are synonymous. *Emys laevis* has already been synonymized by Lydekker and Boulenger with *Platemys bowerbanki* under the name *Podocnemis bowerbanki*. They have also synonymized, as already mentioned, *Emys conybearii* with *Emys delabechei*, again as a species of *Podocnemis*. Only the type of *Emys conybearii* approaches completeness, but all four specimens, though differing in size, are

congruent in every other determinable aspect, and unfortunately in none of them do we know the gular-intergular pattern so important in pelomedusine taxonomy. *Emys laevis* in which a portion of the first neural is present shows that the latter is as strikingly elongate as in

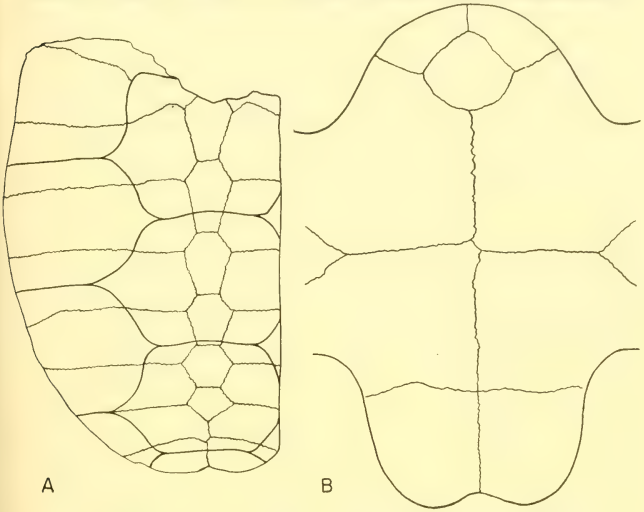

Fig. 4. *Platemys bowerbanki* Owen. A. Dorsal view of type shell. B. Ventral view of type shell. (Both after Owen and Bell.) 1/4 natural size.

Emys conybearii. While *Emys laevis* does not exhibit the transversely divided first vertebral of *Emys conybearii*, the transverse sulcus may in this smaller and younger specimen have been placed more anteriorly, on that portion of the first neural which is not preserved (see Fig. 2). Alternatively, the transverse division of the first vertebral in the type of *P. conybearii* may be an abnormality.

Assuming that the four types of Owen and Bell represent a single form, there is still one further complication. Gray in 1870 in a single publication proposed three distinct generic names for three of the four forms here regarded as synonymous: *Palemys* with the type *Emys laevis* Bell (p. 51); *Palaeochelys* with the type *Platemys bowerbanki* (p. 64); and *Palaeaspis* with the type *Emys conybearii* (p. 73).

Palaeochelys Gray 1870 is preoccupied by *Palaeochelys* H. v. Meyer 1847, but the other two names appear to be available. Since neither name has any sanction deriving from usage — both having been universally ignored since their erection — I choose *Palaeaspis* as the generic name of the pelomedusine of the London Clay, on the ground that the type species on which this name is founded has as its type the most complete and best specimen of the four here discussed.

The oldest specific name for any of the group is *bowerbanki* Owen and the correct name for the single species involved will then be *Palaeaspis bowerbanki* (Owen). The genus may be rediagnosed as follows:

Palaeaspis Gray 1870

Type. Emys conybearii Owen.

New diagnosis. A flattened pelomedusid resembling *Podocnemis expansa* in shell characters and adult size but without a vertebral keel and with a very elongate first neural (*ca.* 2½ times as long as wide) and with the first vertebral divided transversely to form two successive scutes.

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BREVIORA

Museum of Comparative Zoology

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SYSTEMATIC AND OTHER NOTES ON SOME OF THE SMALLER SPECIES OF THE ANT GENUS RHYTIDOPONERA MAYR

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Museum of Comparative Zoology
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The following notes concern a few species belonging to the *impressa* and *metallica* groups of the genus *Rhytidoponera* Mayr. These forms have been included by most recent authors in *Chalcoponera* Emery, but I have shown (Brown, 1953, Breviora, No. 11, p. 2) that Emery's group cannot be separated generically, or even subgenerically, from *Rhytidoponera*. The present problem consists simply of recognizing the specific groupings in question by means of their external characters, chiefly utilizing the workers for study objects, and making the appropriate synonymic reductions. The salient characters will be given briefly and informally with a view toward rendering identification more rapid and certain than has heretofore been possible.

Cabinet investigation is based upon material in the Museum of Comparative Zoology at Harvard University, most of which was gathered in Australia by Prof. W. M. Wheeler, or through his correspondents and contemporary colleagues, and by myself during the course of a recent year-and-a-half stay in Australia under the auspices of the United States Educational (Fulbright) Foundation and of the Parker Fellowship Fund of Harvard University.

Other papers on various groups of *Rhytidoponera*, intended to follow this pattern, are under preparation.

GROUP IMPRESSA

This closely interrelated series of forms comprises *R. impressa* (Mayr) and its erstwhile varieties with their synonyms. *R. aenescens* Emery of New Guinea may also belong in this group, but no specimens have been examined for the present work. The Australian fauna contains three species of the group as far as known, all similar in general details of structure, and all of similar size. The body is slightly larger than in most members of the more common *metallica* group, and generally more slender. The head is only slightly longer than broad, and the occipital lobes or "ears" are much less perfectly developed than in *metallica*, so that in direct dorsal cephalic ("full face") view, the occipital border appears approximately straight or even feebly convex. In lateral view, the weakly developed occipital lobes are seen as lamellate flanges, the sharpness of curvature of which affords a good species criterion (see below). Most characteristic of the group is the gently but distinctly constricted or "saddled" alitrunk as seen from the side. This formation is due to a concavity or gradually rounded stepping in the region of the posterior mesonotum and anterior propodeal dorsum. The legs and antennae are longer and more slender than in *metallica*, in keeping with the more rapid locomotion of the *impressa* group species.

Distribution, as known, runs from New Guinea down along the mountain chains paralleling the eastern Australian coast. The normal habitat is rainforest or, in the southern part of the range in Victoria, in moist or wet sclerophyll (eucalypt-dominated) forest. The nests are usually built in rotten logs or sticks lying on the forest floor, but in areas where rotten wood is not available, *R. chalybaea* at least will nest directly in the soil or beneath rocks.

When the nest is breached, the workers scatter rapidly and hide; some workers will feign death, but not as readily nor for so long a time as in the case of *metallica*. The colonies are small, generally containing 30 to 250 workers and one dealate queen, but mature nests will often produce large broods of winged males and females. Sexual brood production occurs during the end of the rainy season, and circumstantial evidence indicates that a normal nuptial flight commonly occurs during the first part of

the dry season, even though rainy seasons are virtually opposite in the northern and southern parts of Australia. Isolated nest-founding queens are found in conditions resembling those of the usual ant nest-formation pattern throughout the respective dry seasons in the different parts of the range. The *impressa* group species, along with just a few other forms (probably including *R. aspera* and *R. croesus*), are exceptional among *Rhytidoponera* groups in the "normality" of their production of both sexual forms uninidally and with apparently clear-cut periodicity, and their method of nest foundation through normal, fertile, dealate females. Most other species of the genus appear to deviate from this pattern considerably, and in these forms, which often seem to lack entirely a distinguishable female caste, the method of nest foundation is still unknown.

In studying fairly abundant material of this group from a wide range of localities, I could distinguish only three species in the continental Australian fauna, one of which also occurs in New Guinea. The three Australian species, at least from the present material, appear to replace one another from north to south in the narrow eastern "wet strip" with very slight geographical overlap. Applying the prior names for these populations, we find *R. purpurea* Emery in New Guinea and in the rainforests of the Cairns-Atherton Tableland area of North Queensland, *R. impressa* (Mayr) beginning on the southern part of the Atherton Tableland and occurring at various intermediate points southward to the vicinity of Brisbane, in southeastern Queensland, and *R. chalybaea* Emery, starting probably in the region just north of Brisbane on the mountaintops and ranging south at least to Melbourne in south central Victoria. Though the characters are rather slight for the separation of *purpurea* from *impressa*, they appear to be discontinuous together, and I have little doubt that they delimit two distinct species.

R. chalybaea, on the other hand, seems to be distinguishable from *impressa* only on the basis of coloration, and a rather tenuous and cabinet-labile metallic coloration at that. At the present writing, the possibility still exists that these two forms are mere geographical variants of the same species, although at Montville, in the Blackall Range, about 50 or 60 miles north of Brisbane, typical blue *chalybaea* were found nesting under rocks on the

cleared top of the ridge, while only a few hundred feet below in the rainforest, I consistently took only the brown typical *impressa*. One series, however, coming from the environs of Brisbane, showed the brown color of *impressa* with just the feeblest hint, at high magnifications, of bluish metallescence. I do not attach special significance to this series because it is an old collection and may have undergone a change in the structural and pigmental coloration. All collections from the small remaining part of southeastern Queensland to the south of Brisbane have proven to be of the typical blue *chalybaea*, and I can testify that the population on Tambourine Mountain, only some 40 miles south of Brisbane, is uniformly of blue color. It is obvious that the populations inhabiting the scattered rainforest patches close to Brisbane require further study in order to settle this question finally, and it is fortunate that these are so readily accessible.

Rhytidoponera chalybaea Emery. New status

Rhytidoponera impressa var. *chalybaea* Emery, 1901, Ann Soc. Ent. Belg., **45:** 51, worker. Type locality: New South Wales.

Ectatomma (*Rhytidoponera*) *cyrus* Forel, 1910, Rev. Suisse. Zool., **18:** 13, worker, female. Type locality: Ballina, New South Wales, (W. W. Froggatt). **New Synonymy.**

Rhytidoponera (*Chalcoponera*) *cyrus*, Emery, 1912, Deutsch, ent. Zeitschr., p. 81, discussion of worker characters and relationships.

Rhytidoponera (*Chalcoponera*) *aspera* var. *scabrior* Crawley, 1925, Ann. Mag. Nat. Hist., (9) **16:** 590, worker. Type locality: Lismore, New South Wales (Deuquet). **New Synonomy.**

This, the southern representative of the *impressa* group in Australia, is metallic blue or purplish-blue in color, with the gaster matching the head and alitrunk, but usually slightly duller. Legs and antennae light to sordid ferruginous, contrasting strongly with the body color, especially so in life. The pattern of fine striolation on the second gastric (second postpetiolar) segment varies widely in direction even in uninidal series. Occipital lobe or flange seen from the side narrowly rounded, forming a near right angle, as contrasted with the more broadly rounded and lower flange of *purpurea;* there is, however, some slight variation in the flange of *chalybaea*, and rare specimens isolated from their nest series may approach the condition seen in *pur-*

purea. Seen from the side, the anterior and dorsal faces of the petiolar node usually meet in a blunt angle, though here again occasional specimens may approach the more sharply angulate condition of *purpurea*. In differentiating from the very similar-appearing *purpurea*, fresh series are most easily told by the different coloration and the lateral occipital lobe conformation. Even old cabinet specimens are readily separable when one gets an eye for these characters.

Emery (1912, *loc. cit.*) demonstrated the true relationship of Forel's *cyrus*, originally falsely compared, but he did not carry his observations to the formal synonymy they indicate. From Emery's remarks, it appears that the *cyrus* cotype he had from Forel was only a small worker of *chalybaea* with the usual characteristics of such specimens. A cotype of Crawley's variety *scabrior* in the Museum of Comparative Zoology agrees well with the remainder of the *chalybaea* series at my disposal; Crawley knew this group so poorly that he attached his variety to an entirely different species with similar coloration, *R. aspera* (Roger), which is discussed farther below.

Localities for material in Museum of Comparative Zoology: VICTORIA: Ferntree Gully, under stones (C. Barrett, W. Brown). Slope of Warburton Range immediately above Warburton, *ca.* 400 M., tree-fern gully remnant, in rotten log (Brown). Millgrove, in rotten logs (F. E. Wilson, Brown). NEW SOUTH WALES: Kurrajong (W. W. Froggatt). National Park (W. M. Wheeler, A. M. Lea). Lismore; Armidale (C. F. Deuquet). Coff's Harbour, tree-fern gully near coast, rotten log (Brown). Hornsby; Sutherland (Wheeler). Dorrigo (W. Heron). QUEENSLAND: National Park, MacPherson Range (H. Hacker). Toowong (Wheeler). "Brisbane" (Wheeler). Stanthorpe (E. Sutton). Tambourine Mt., rotten logs in rainforest, ca. 400 M.; Montville, Blackall Range, *ca.* 500 M., under stones on ridge top, grassy cleared rainforest area (Brown). Winged forms are in the nest in September and October in Victoria, in May in the Blackall Range.

Rhytidoponera impressa (Mayr)

Ectatomma impressum Mayr, 1876, Jour. Mus. Godeffroy, **12**: 92, worker, female. Type locality: Gayndah, Queensland.

Rhytidoponera (*Chalcoponera*) *impressa*, Emery, 1912, Deutsch. ent. Zeitschr., p. 77, worker, in key.

When fully colored, this distinctive species is deep reddish brown to chocolate brown, with conspicuous light reddish-ferruginous legs and antennae; a faint trace of coppery reflection may occasionally be present on the dorsal surfaces of the body, but this is negligible in the material I have seen. I can find no other characteristics but the general body color to distinguish this form from *chalybaea* (*q.v.*). The color and the rectangularly rounded lateral occipital lobe in lateral view will serve to separate *impressa* from *purpurea*, even where the two forms occur only a few miles apart at Millaa Millaa and Malanda on the Atherton Tableland. During several days' collecting at Malanda, I found only *purpurea* there, whereas at Millaa Millaa, which has not been systematically collected for the genus, only *impressa* has so far been found.

The Millaa Millaa series was taken by P. J. Darlington, while all of my own collections were made in rainforest on the slopes and at the foot of the Blackall Range, where this species is common in rotten logs and sticks lying on the forest floor, often in exceedingly dense shade. At Kondalilla Falls and along the Obi-Obi River, I found something like twenty nests of *impressa*, about half of which had numerous males and females together in the winged condition and mostly fully colored (May, 1951). Dealate nest queens were found easily in most colonies opened, one to a colony. No single isolated females were found during this period.

Probably Brisbane is just about at the southern limit of this species, which must occur in most suitable rainforest patches and perhaps also in gallery forest along almost the whole of the east Queensland "wet strip" to as far north as the southern edge of the Atherton Tableland. Millaa Millaa is about 2500 feet (760 M.) above sea level, and is rainforest country on rich volcanic soil, much of which has been cleared to grassland for grazing. Malanda, a little farther north and occupied by *R. purpurea*, is similar country lying at an altitude of about 2400 feet. No barriers of any consequence fall between the two localities.

RHYTIDOPONERA PURPUREA (Emery). New status

Ectatomma impressum var. *purpureum* Emery, 1887, Ann. Mus. Civ. Stor. Nat. Genova, (2) **5:** 444, worker, female. Type locality: Hatam, New Guinea (Beccari).

Ectatomma (*Rhytidoponera*) *impressum* var. *splendidum* Forel, 1910, Rev. Suisse Zool., **18:** 12, worker. Type locality: Kuranda, near Cairns, Queensland (R. Turner). **New Synonymy.**

This species differs from *R. chalybaea*, to which it is at first sight very similar, in the very narrow, broadly rounded lateral occipital flange or lobe as seen in lateral view. The difference is slight, and can best be appreciated through comparison of series of both forms. The angle between the anterior and dorsal faces of the petiolar node is usually well-marked, and even sharp, but there is enough variation in this character among all *impressa* group species to render it of little discriminatory value.

The color of the head and alitrunk varies somewhat by nest series, but in fresh specimens is basically a rich, slightly reddish purple, usually with elusive greenish or bluish highlights. The gaster has a slightly contrasting metallic coloration of a predominantly bluish-green hue, often somewhat dull compared to the purple of head and alitrunk; the gastric color seems constant and affords a good distinguishing character even in most old cabinet specimens. The legs and antennae are considerably darker than in *chalybaea*, and appear more nearly black, especially to the naked eye in living specimens, though tending to fade to light brownish in old cabinet specimens: the size averages slightly larger.

The above description is taken from long series of specimens obtained at Kuranda, Queensland, in rotten logs in rainforest by myself, as well as from older series from the same locality taken by Wheeler and T. Greaves, and from the Cairns district by F. P. Dodd. The species is also common along the Black Mountain logging road, on the western side of the MacAlister Range north of Kuranda. I found it somewhat less common at Malanda, in rainforest at 2400 feet (730 M.) altitude on the Atherton Tableland, also in rotten logs, although one isolated nest-founding female was taken here in the "peat" about the base of an epiphytic fern growing on the trunk of a rainforest tree about seven feet above the ground. I visited these localities

during October and the beginning of November, 1950, which is at the end of the dry season in this district. During this time, many dealate females were found isolated with small larval broods, and others were found as queens of established nests, but no winged forms or sexual pupae in obvious stages were seen; Wheeler, however, took the winged forms at Kuranda in October.

I have seen one specimen from New Guinea, collected in the Rawlinson Mountains and sent by Dr. H. Kutter under the name "var. *purpurea* Emery." While an old and somewhat discolored specimen, this example does not seem to possess any notable features by which it can be separated from the Kuranda series of *splendida*. I am expressing this lack of difference by synonymizing Forel's variety, but I hope that a future study of further New Guinea material will test the synonymy thoroughly. *R. purpurea* should be expected to occur in the scattered rainforest patches following the mountains up the eastern side of Cape York Peninsula.

GROUP METALLICA

The group of species related to *R. metallica* (Fred. Smith) is in considerable taxonomic confusion, due chiefly to the high degree of geographic variability shown by *R. metallica* itself over a wide range and to the circumstance that certain very similar species have been included in *metallica* as varieties. Most of the forms have been described two or three times under different names and with the briefest and often most irrelevant of characterizations. Such descriptions, which variety-describers considered it their privilege to publish in keeping with the humble status of the variety, are the bane of ant taxonomy, and they show little reflection of the true taxonomic situation. During the 1930's, Clark added to the complications afflicting this group by describing a number of doubtful species based chiefly on variable characters, such as color of metallescence, but apparently without considering sufficiently the degree of variation even in his limited series. In a subsequent paper, I shall try to unravel some of the more difficult complexes in this group to the extent of the material currently available to me, but at this time I am ready to deal with two of the less common species with relatively uncomplicated and obvious synonymy and relationships.

The *metallica* group species are among the smallest *Rhytidoponera*, and are distinguished by having an evenly convex alitruncal profile and prominent posterolateral occipital lobes, or "ears," which often cause the occipital border to be broadly and rather deeply excavate as seen from direct dorsal cephalic view. Coloration is often brilliantly metallic blue, green or purple, but some species lack metallescence completely, and in others it is very variable. Antennal scrobes are lacking or merely suggested, and are not ever so strong as in the *victoriae* complex; however, the *victoriae* complex is hardly more than a subgroup of the *metallica* group. The petiolar node is thick but erect, with steep anterior and posterior faces. The treatments of *R. aspera* and *R. croesus* do not require further general comment.

Rhytidoponera aspera (Roger)

Ponera metallica var. *aspera* Roger, 1860, Berlin. ent. Zeitschr., **4:** 308, worker. Type locality: Australia.

Rhytidoponera (*Chalcoponera*) *aspera*, Emery, 1912, Deutsch. ent. Zeitschr., p. 77, worker, in key.

Rhytidoponera (*Chalcoponera*) *arnoldi* Forel, 1915, Arkiv. f. Zool., **9** (16): 14, worker. Type locality: Healesville, Victoria (H. A. Arnold). **New Synonymy.**

This ant is similar to *metallica*, but is larger and stouter, and is of a brilliant metallic green color (blue or purplish in some old dried specimens) with contrasting reddish ferruginous legs, antennae and mandibles. The second gastric (second postpetiolar) segment is largely smooth and shining, but has some fine, superficial, diverging oblique striae anteriorly, mainly toward the sides above. Forel's characterization of *arnoldi* fits very well with the specimens at hand, and these in turn agree with the essentials of Roger's description. Fortunately, the color, size and details of gastric sculpture leave very little doubt about the identity of this species and its synonym, as it is the only species combining all these characteristics in its genus.

This species is not common in collections, I find, and I have myself met with it only once in the field, at Upper Ferntree Gully Station, Victoria, where strays were found running up the trunk of a large manna gum by the station driveway. These workers were very conspicuous, but I did not succeed in finding the nest,

nor did I see them at the same place on other visits. Small series or strays have also come to me from various Victorian localities: Portland (H. W. Davey); Belgrave (F. E. Wilson); Melbourne (?) (H. Edwards), and I have a pin labelled "Fernshaw," a locality unknown to me and possibly outside Victoria. A single dealate queen was found on the same pin with two *R. chalybaea* dealates, collected by H. Hacker at National Park, MacPherson Ranges, in southeastern Queensland. If this record is correct, the species must range through the moister districts of eastern New South Wales, though no records are available from that state. The locality records indicate a habitat in eucalypt forest of the intermediate to high rainfall types. I have seen a single specimen collected at Auckland, New Zealand, from poles originating at an unknown Australian port, but the species appears not to have colonized New Zealand.

Rhytidoponera croesus Emery

Rhytidoponera croesus Emery, 1901, Ann. Ent. Soc. Belg., **45:** 50, worker. Type locality: New South Wales.

Rhytidoponera (*Chalcoponera*) *croesus* Emery, 1912, Deutsch. ent. Zeitschr., pp. 77, in key, and 81, worker.

Rhytidoponera (*Chalcoponera*) *fastuosa* Santschi, 1916, Bull. Soc. ent. France, p. 174, all castes. Type locality: Australia (Duchaussoy), probably New South Wales. **New Synonymy.**

Chalcoponera victoria (*sic*) var. *andrei* Wheeler and Chapman, 1925, Philippine Jour. Sci., **28:** 60, worker. Type locality: cited in error as from the mountains of Victoria; *recte* Dorrigo, New South Wales (W. Heron). **New Synonymy.**

R. croesus workers and females are recognizable by means of the low, thick, anteriorly rounded petiolar node, the posterodorsal border of which slightly overhangs the posterior face. The color is also distinctive, being basically bright ferruginous, but overlain more or less completely and heavily with deep, brilliant purple metallescence. In the extreme form, represented by what Santschi described as *fastuosa*, most of the head, alitrunk, petiole and gaster is densely purple in color, whereas intermediates like the types of the original *croesus* may have only the alitrunk thoroughly saturated with purple, while the head, the gaster, or both remain more or less pure ferruginous like the appendages. Single nests, excepting tenerals, are usually fairly uniform

through the series, but a collection containing series from several nests shows all degrees of intergradation, even from close localities within the restricted distribution in eastern New South Wales and southeastern Queensland. Santschi's description is confused by his comparison with *croesus*, which species he credits to Forel as author. It seems that his comparison is really made against *cyrus* Forel (*chalybaea* Emery, see above), and in this connection his description makes more sense. The variety *andrei* was described due to a highly improbable series of errors, involving mislabelling of the specimens and misreading even of these labels. Dr. J. W. Chapman has reviewed this situation and produced three worker cotypes. These are faded purple specimens, and their character and kind of mounting shows that they are part of an old series Wheeler had received from Dorrigo, New South Wales, from W. Heron, the collector. "*Victoriae*" of someone's temporary label was misread as "Victoria," but no specimens of this species have yet been recorded from Victoria. The supposed introduction into Luzon must also be regarded as a doubtful record, since the relevant specimen is apparently missing.

Material in Museum of Comparative Zoology: from eastern New South Wales: Bulli Pass (W. M. Wheeler). Dorrigo (W. Heron). Lismore (C. F. Deuquet). Queensland: Tambourine Mt. (A. M. Lea; Brown) running on rotten tree trunk in dense rainforest at 1100 feet. Stanthorpe (E. Sutton). National Park, MacPherson Range (H. Hacker). *R. croesus* is apparently restricted to the wet subtropical forests of eastern New South Wales and extreme southeastern Queensland.

BREVIORA

Museum of Comparative Zoology

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A REVIEW OF THE COXALIS GROUP OF THE ANT GENUS STICTOPONERA MAYR

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The genus *Stictoponera* is a chiefly Oriental and Papuasian assemblage of typical ectatommines. In my revision of the tribe Ectatommini, to be published elsewhere, I have enlarged *Stictoponera* to include the species from the same general region formerly placed in *Wheeleripone* Mann and *Rhopalopone* Emery. With the new composition, *Stictoponera* includes three or four rather vague and intergradient species-groups, of which the largest and most familiar comprises species with a low, paniform petiolar node and a distinct tooth on the dorsum of the posterior coxa. These species are the "typical" members of *Stictoponera* related to the genotype, *S. coxalis* (Roger). The species formerly called *Wheeleripone albiclava* Mann perhaps belongs in the *coxalis* group, but it is aberrant in sculptural detail and is somewhat intermediate to other groups in the shape of the node; it will not be discussed here.

The *coxalis* group is most in need of revision at the species level, and the notes offered here amount to a revision of those species already described of which recognizable material is now available to me. The majority of this material is in the Museum of Comparative Zoology, Harvard University, and is due mainly to the fine collecting of Dr. J. W. Chapman in the Philippines and the late Eric Mjöberg in northern Borneo. Dr. Chapman also has furnished considerable ecological information and other aid concerning many of the species, and it was he who inspired the present work and encouraged it continuously.

Since a key to the species is not yet possible because of doubts about several species not seen by myself, I can offer only the outline of characters as follows:

A. Second postpetiolar (IV abdominal) segment coarsely longitudinally costate, at least on the basal half.
   1. Eyes placed in the posterior quarter of the sides of the head: *S. posteropsis* Gregg.
   2. Eyes placed between the middle point and the posterior quarter of the sides of the head: *S. coxalis* (Roger), *S. costata* Emery, *S. birói* Emery.

B. Second postpetiolar (IV abdominal) segment not costate.
   1. Eyes placed anterior to middle of sides of head (according to original descriptions): *S. crassicornis* Forel, *S. spiralis* Karawajew.
   2. Eyes placed at or slightly behind the middle of the sides of the head: *S. bicolor* Emery, *S. binghamii* Forel, *S. laevior* Forel, *S. menadensis* Mayr.

In addition to the species listed above, with their synonyms, I have also seen two apparently undescribed species of group B,2.

Stictoponera laevior Forel

Ectatomma (*Stictoponera*) *laevius* Forel, 1905, Mitt. Naturh. Mus., Hamburg, **22:** 7, worker. Type locality: Tjibodas, Java.

Stictoponera laevior var. *avia* Forel, 1912, Notes Mus. Leyden, **34:** 96, all castes. Type locality: Nongkodjadjar, Java. **New Synonymy.**

A small, slender shining species with sparse foveation. The species was described from a unique, obviously teneral; var. *avia* refers to fully pigmented specimens. I have seen one worker from Poentjak, Java, no collector cited.

Stictoponera menadensis Mayr

Ectatomma (*Stictoponera*) *menadensis* Mayr, 1887, Verh. zool.-bot. Ges. Wien, **37:** 539, nota, worker.

Stictoponera stylata Menozzi, 1925, Philippine Jour. Sci., **28:** 440, pl. 1, figs. a, b, worker. **New Synonymy.**

Stictoponera menadensis var. *obscura* Santschi, 1932, Mem. Mus. Hist. Nat. Belg., (hors sèrie) **4** (5): 11, worker. **New Synonymy.**

This species is of medium size, shining, with full adult color dark reddish-brown to piceous, gaster black. Mesonotum with a

smooth longitudinal median strip free of foveation, extending in some specimens for a short distance onto the posterior portion of the pronotum; the latter otherwise always rather closely foveate. This species is apparently the common lowland and foothill *Stictoponera* in the East Indies and the Philippines. It occurs on Java and Sumatra together with *S. bicolor*, a very closely related species, but no intergrades between the two have yet been reported from these localities. I have seen no specimens of *menadensis* from mainland Asian localities, and records from the mainland are scarce in the literature. From the present data, *S. menadensis* appears to be a peripherally distributed form in the process of being replaced by *S. bicolor*, the latter spreading from southeastern Asia outwards into the archipelagic regions.

The types of *S. menadensis* and the var. *obscura* come from Celebes, and Santschi's description mentions no characters differentiating his variety from normal *menadensis* populations. The type of *S. stylata* came from Mt. Makiling, Luzon, and is present in the collection of Dr. J. W. Chapman. Unfortunately, Dr. Chapman's collection was somewhat damaged during the period when it was hidden in the mountains of Negros while the owner was interned in prison camp during the late war, and some of the specimens of *Stictoponera* became separated from their labels, among them the *stylata* type. Dr. Chapman and I have, however, segregated a small group of specimens in the collection by elimination of possibilities, and some specimen of this group is the type of *stylata*. Since all the specimens in this group are clearcut *menadensis*, and since *menadensis* is the common species on Mt. Makiling, we concluded that the above synonymy is required. Menozzi's description offers no characters in opposition to this decision, and the description itself could be the basis of the synonymy. Obviously, Menozzi did not have a clear idea of the identity of the typical *menadensis*, and merely described it under a new name. In addition to the Mt. Makiling record, the collections of Dr. Chapman and the Museum of Comparative Zoology contain series from the following Philippine localities: Sarai, Paete, Laguna (Luzon) (R. C. McGregor). Mt. Manapla, Negros Occidental (F. del Rosario); Lake behind Dumaguete; Cuernos Mts., several collections, 1800 to about 3600 feet, Negros Oriental (J. W. Chapman). Momungan and

Lanao, Mindanao (Chapman and D. Empeso). Los Baños, Luzon (F. X. Williams). Samar I. (McGregor et al). Kolambugan, Mindanao (C. S. Banks). There are also series from Borneo: Mt. Tibang, 1400 M., and Pajan (E. Mjöberg). Kuching (Hewitt). Sumatra: Wai Lima, Lampongs (Karny). In the Philippines, nests are built in rotten logs and tree fern stems and under moss on rocks. Dr. Chapman informs me that this, the most common *Stictoponera* in the Philippines, is usually seen running over foliage or resting in the axils of large leaves in wet foothill ravines.

Stictoponera bicolor Emery

Ectatomma (*Stictoponera*) *bicolor* Emery, 1889, Ann. Mus. Civ. Stor. Nat. Genova, **27:** 493-494, worker.

Ectatomma (*Stictoponera*) *bicolor* var. *minor* Forel, 1900, Jour. Bombay Nat. Hist. Soc., **13:** 316, worker.

Stictoponera menadensis subsp. *minor*, Brown, 1948, Psyche, **54:** 264, (teneral) worker.

Stictoponera bicolor, Brown, 1950, Wasmann Jour. Biol., **8:** 245-246, worker, synonymization of var. *minor*.

Since this form was described, not a few authors, including myself, have been confused by it one way or another. It is very close to *S. menadensis*, and has the same head shape, with prominently projecting posterior occipital lobes or "ears" and a corresponding, deeply concave, border between them as the head is viewed in full face. The eyes are rather large and situated well posterior to the middle of the sides of the head. The size is as in *menadensis*, with some series averaging a trifle smaller, but the color of the alitrunk is lighter and brighter, varying shades of orange-ferruginous. The head varies from about the same color as the alitrunk to piceous, the darker color being more common. The median smooth strip of the *menadensis* mesonotum is replaced in *bicolor* by fine, indefinite, more or less opaque longitudinal rugulation, and the sculpture throughout is usually stronger, closer and less shining. *S. bicolor* may or may not possess minute propodeal denticles; these appear to be an allometric character of the sort that grades through within and between series. The tenerals are straw-colored, and appear very different from fully-pigmented individuals in the same nest series.

Like *S. menadensis*, the present species has often been misidentified. It is still possible, of course, that *menadensis* and *bicolor* are mere geographical color representatives of one species, but from the present material they can still be separated. The record of *bicolor* from the Philippines is based on a male of uncertain species; no authentic *bicolor* records are yet known for these islands.

I have reviewed material from the following localities: Indochina: Coxan and Dong Mo (F. Silvestri). Hainan I.: Dwa Bi; Ta Han; Loi Molia; Nodoa (J. L. Gressitt). Sumatra: Wai Lima, Lampongs (Karny). Java: Pemalang (L. G. E. Kalshoven). Hong Kong: no further locality (Ris). Emery described this species from material taken in various Burmese localities, both upcountry and in Tenasserim.

Stictoponera binghamii Forel

Ectatomma (*Stictoponera*) *binghamii* Forel, 1900, Jour. Bombay Nat. Hist. Soc., **13:** 137, worker, female. Type locality: Burma [Pegu Yoma?].

Stictoponera borneensis Emery, 1901, Ann. Mus. Civ. Stor. Nat. Genova, **40:** 662, nota, worker. Type locality: Sarawak. **New Synonymy.**

This species resembles *S. menadensis*, but lacks the prominent lateral occipital ears and has a normal full adult coloration of rich ferruginous red. The eyes are at or close behind the middle of the sides of the head, and the posterior occipital border is straight to gently concave in different specimens and according to the view. Small teeth are present on the propodeum of most individuals. The insect is rather strongly shining, the foveation tending to be less dense than in *menadensis*, and the middle of the pronotum has a variable smooth, shining area free of foveae. The petiolar node seen from above is approximately as broad as long, length being favored in larger specimens. The second postpetiolar segment is very smooth and shining, foveation very indistinct and shallow and virtually confined to the sides. The antennal funiculi are rather thick, the median segments broader than long even in the largest specimens.

At first I had separated *binghamii* from *borneensis*, though the two were obviously closely related, but I now find that specimens referable to both were taken by Dr. Chapman on the same date at the same locality near his camp in the Cuernos

Mts., Negros Oriental, Philippines; these probably represent a single nest series, and in any case, it is apparent from a study of the full series, including those in Dr. Chapman's personal reserve collection, that the large and small forms are only allometric extremes of one form. I have also seen material referable to the same species from Tutu River, North Borneo (Mjöberg) and a specimen from "Pedada-B., Lampongs, Sumatra," unknown collector, and I feel sure that Forel's Burmese and Emery's Bornean types are merely the small and large extremes of one variable species, though I have not examined type material. Dr. Chapman tells me that he found this species nesting in rotten logs in ravines in forest.

STICTOPONERA CRASSICORNIS Forel New status

Ectatomma (*Stictoponera*) *binghami* subsp. *crassicornis* Forel, 1912, Zool. Jahrb. Syst., (suppl.) **15:** 51, worker. Type locality: Indrapura, Sumatra.

Forel states that the eyes are anterior to the middle of the sides of the head, which if true would separate this form from *binghamii* very decisively. The other characters cited, however, indicate considerable similarity, and Forel may well have been mistaken about the eyes. The description of *S. spiralis,* the next species following, also claims a similar position for the eyes. Among all the series available to me, I have seen no *Stictoponera* specimens with the eyes in front of the middle of the sides of the head. In any case, it is very unlikely that *crassicornis* can be a race of *S. binghamii,* since the known distribution of the latter straddles the Sumatran type locality of *crassicornis.* Provisional specific rank is indicated for *crassicornis* until the type can be re-examined.

STICTOPONERA SPIRALIS Karawajew

Stictoponera spiralis Karawajew, 1925, Konowia, **4:** 79-81, worker.

This species, also described from Sumatra, reads very much like *S. crassicornis* in what seem to be the significant features, and it is possible that the two names are synonymous.

STICTOPONERA BIRÓI Emery

Stictoponera birói Emery, 1902, Term. Füzetek, **25:** 154, worker.

S. birói, the only species of the genus so far recorded from New Guinea, appears to be quite distinct from the Indomalayan forms on the basis of its original description.

Stictoponera posteropsis Gregg

Stictoponera posteropsis Gregg, 1952, Psyche, **58:** 77-80, figs. 1, 3a, 3c, female.

This very aberrant species has large eyes situated almost at the extremes of the posteriorly salient occipital corners. The type, a dealate female, came from Sumatra, but I have seen a few additional worker specimens from the Cuernos Mts., Negros Oriental (Dr. Chapman), taken in rotten logs in forest ravines. Some of these workers are larger even than the female type, and their color is dark piceous instead of ferruginous red.

Stictoponera costata Emery

Ectatomma (*Stictoponera*) *costatum* Emery, 1889, Ann. Mus. Civ. Stor. Nat. Genova, **27:** 494, worker. Forel, 1900, Jour. Bombay Nat. Hist. Soc., **13:** 316, 317, worker. Bingham, 1903, Fauna Brit. India, Hym., **2:** 83, worker.

Ponera rugosa Fr. Smith, 1857, Jour. Proc. Linn. Soc. London, Zool., **2:** 66, worker; name preoccupied by Le Guillou, 1840. **New Synonymy.**

Stictoponera costata Emery, 1901, Ann. Mus. Civ. Stor. Nat. Genova, **40:** 662, worker.

Stictoponera costata var. *unicolor* Forel, 1901, Rev. Suisse Zool., **9:** 335, worker, male. **New Synonymy.**

Stictoponera rugosa var. *parva* Forel, 1913, Zool. Jahrb. Syst., **36:** 6, worker. **New Synonymy.**

?*Stictoponera costata* var. *simalurensis* Forel, 1915, Tijdschr. v. Ent., **58:** 23, worker. **New Synonymy,** with doubt.

Stictoponera costata var. *pinealis* Wheeler, 1929, Boll. Lab. Zool. Portici, **24:** 31. **New Synonymy.**

Stictoponera wallacei Donisthorpe, 1932, Ann. Mag. Nat. Hist., (10) **10:** 447, *nom. pro Ponera rugosa* Fr. Smith. **New Synonymy.**

The key reference to this form is that of Emery for 1901 (*loc. cit.*) in which he cites variation in size among specimens from Sumatra and Mentawei (the *costata* type locality is in Burma) and suggests, but does not declare, the synonymy with *Ponera rugosa* of Smith. He also cites differences between *costata* and a type of *coxalis* he received from the Roger Collection in Berlin, the latter differing "from *costata* in the much less coarse sculpture of the whole body, and especially of the abdomen, and in the more slender antennae, with the flagellar segments less thick, the third to the fifth longer than thick (thicker than long in *S. costata*)." I am able to confirm and amplify Emery's differentia-

tion of these two species, as will be seen below under *S. coxalis*. In the series I refer to *S. costata*, stemming from ten localities ranging from Malaya to Borneo and Mindanao, there is a large amount of variation in size, color, and degree of development of sculpture; the variation in sculpture of the first gastric (postpetiolar) segment is particularly notable. The prevailing color in North Bornean specimens is rich ferruginous red, but certain specimens from Mindanao are piceous, and the female type of *pinealis* Wheeler, from Penang, is deep reddish with the gaster black. The variety *unicolor* Forel, based largely on a Bornean male, was never really differentiated from the types of *costata*. The various color conditions are constant within some nests, but not in others; and considering the long teneral period shown by ants of this genus, the relative conspicuousness of tenerals under the collector's eye, and the chances of color changes in preservative and cabinet, I can attach no great importance to color by itself. In the present material, color, size, variation in the shape of the lateral occipital "ears" or lobes, and sculpture are discordant geographically, so that it seems not possible to recognize objective geographical races based on these characters.

Emery mentions, as stated above, that certain Sumatran series varied in size, and it seems likely that Forel's variants *parva* and *simalurensis* are merely small *costata*. The Bornean specimens show significant size variation even between relatively close localities. Essentially, the sculpture of *costata*, except for the very coarsely and regularly costate second gastric (second postpetiolar or IV abdominal) segment, is in the form of large, rather deep punctures, foveae or pits, with more or less distinct and smooth, shining spaces between them. On the first gastric segment, the punctures tend to be more elongate, and the spaces between them, particularly toward the posterior edge of the discal surface, begin to form more or less definite longitudinal ridges or costae. In some specimens, such as those from Mt. Penrissen and Mt. Tibang, in Borneo, the spaces are broad and shining, and the punctures definitely prevail over the rather weakly suggested costae, while in others, such as most Bornean specimens and the *pinealis* type, the costae are closer and sharper on the first gastric segment, at least posteriorly, and the punctures are closer together and more elongate. The sculpture of

the remainder of the body follows that of the gaster more or less closely, but differences are harder to see and describe. In spite of these rather distinct differences between extremes, I find that Borneo alone supplies a full set of intergrades which is enough to obscure any possible taxonomic split based on this character. It therefore seems that Emery was correct in maintaining *costata* as a single taxonomic unit despite the variation he saw. His reasonable suggestion that F. Smith's *rugosa*, from Sarawak, equalled *costata* is also accepted here, and since the name *rugosa* is preoccupied, and Donisthorpe's *nomen novum wallacei* later than *costata*, the name *costata* will remain in use.

I have studied series in the Museum of Comparative Zoology from the following localities: North Borneo and Sarawak: Mt. Penrissen; Mt. Tibang; S. Slau; Brooketon; Pajan; S. Saranibo; Baian River (E. Mjöberg). Mindanao, Lanao district: Maria Christina Falls (J. W. Chapman). Momungan (D. Empeso) Malaya: Penang Island (F. Silvestri), type of var. *pinealis*. Sumatra: Langkat, E. Coast (Jourin).

Stictoponera coxalis (Roger)

Ponera coxalis Roger, 1860, Berl. ent. Zeitschr., **4:** 308, worker.

Ectatomma (*Stictoponera*) *coxale* Forel, 1900, Jour. Bombay Nat. Hist. Soc., **13:** 316, worker. *Nec* Bingham, 1903, Fauna Brit. India, Hym., **2:** 84, fig. 44, worker.

Stictoponera coxalis Emery, 1901, Ann. Mus. Civ. Stor. Nat. Genova, **40:** 662, worker.

Roger described this species very incompletely for modern needs from specimens collected by Nietner in Ceylon. Emery's statement of the differences between *coxalis* and *costata* has already been translated above under *S. costata*. I have been able, through the courtesy of Prof. M. Beier, of the Naturhistorisches Museum, Vienna, to examine a worker (here designated as lectotype, and so labelled) and a dealate female from the type series of *coxalis*, that Roger had early sent to Gustav Mayr. As Emery mentions, the sculpture throughout is considerably finer than in *costata;* it is also denser and consists more predominantly of longitudinal costulation or coarse striation instead of the large, predominating punctures of *costata*, although somewhat smaller punctures are still clearly present and often conspicuous. Under

lower magnifications, *coxalis* tends to appear more opaque generally than does *costata*. On the first gastric segment, there are up to two or three irregular, but rather close and fine longitudinal costae for every one seen in the average *costata* specimen. Also, as mentioned by Emery, the funiculi are notably more slender in *coxalis*, with the third through the fifth (I would include the sixth and possibly also the seventh) funicular segments slightly longer than broad. The same segments are broader than long, though somewhat variable in proportions, in the *costata* samples I have seen.

I agree with Emery's separation of the two species on the present evidence; obviously, however, the two are very closely related. To my knowledge, *S. coxalis* remains known only from the type series from Ceylon, though various authors have followed Bingham in confusing this species with *S. menadensis* and *S. bicolor*. When better collections are available from southern India, it may be necessary to re-examine the relationship of *coxalis* and *costata*.

Note on "*Stictoponera sauteri*"

The name *Stictoponera sauteri* (Chapman and Capco, 1952, Check list of the ants of Asia, Monogr. Inst. Sci. Tech., Manila, **1:** 30) is a combination proposed in error, and actually refers to *Ectomomyrmex sauteri*, a species described earlier by Forel. This species has no connection with *Stictoponera;* the Check List combination was purely an unintentional clerical slip.

BREVIORA

Museum of Comparative Zoology

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NEW OR REDESCRIBED PELOMEDUSID SKULLS FROM THE TERTIARY OF AFRICA AND ASIA (TESTUDINES, PELOMEDUSIDAE)

1. *Dacquemys paleomorpha*, new genus, new species from the Lower Oligocene of the Fayum, Egypt.

BY ERNEST WILLIAMS

In 1912 E. Dacqué described a skull from the Lower Oligocene of the Fayum of Egypt which he referred, with doubt, to *Stereogenys libyca* Andrews. The skull, which is the property of the Staatliches Museum für Naturkunde in Stuttgart, has survived the war. Thanks to the kindness of the authorities in Stuttgart, and especially of Prof. F. Berckhemer and Dr. Karl Dietrich Adam, I have been able to re-examine it.

Re-examination confirms the excellence and accuracy of Dacqué's figures, but it also leaves no doubt that he failed to sufficiently appreciate the uniqueness of the specimen in certain regards. It is unquestionably a new genus of pelomedusid, which may be named and defined as follows:

DACQUEMYS, new genus

Diagnosis. A pelomedusid belonging to the Podocnemis group within the family and possessing the enlarged "carotid canal" and basioccipital-quadrate contact characteristic of that group but differing from the others of the group and from all other members of the family in the extensive squamosal-parietal contact.

Genotype. Dacquemys paleomorpha, new species.

The genotype is at present the only species.

Dacquemys paleomorpha, new species

Type. No. 12645 in the paleontological collection of the Staatliches Museum für Naturkunde, Stuttgart, a skull without mandible.

Type locality. Diieh, Fayum of Egypt.

Horizon. Lower Oligocene.

Specific diagnosis. With the characters of the genus.

Description. A moderately elongate skull (estimated condylobasal length 72mm.) of rather heptagonal shape with a completely covered temporal region and the orbits far forward, these and the nares concealed in dorsal view. No forehead groove. Frontals enter orbit broadly. Interorbital width relatively great. Well defined grooves bounding a nearly equilaterally triangular interparietal scute. Parietal scutes, well indicated by grooves on the bone, large and meeting for a considerable distance posterior to the interparietal scute. Jugal excluded from parietal by the postorbital which is relatively large. Squamosals and parietals in very broad contact. Temporal roof in consequence carried posterior to the cavum tympani. Squamosal in two planes: (1) a dorsal nearly horizontal arched surface joining the parietal paramedially and bordering laterally on the quadrate; (2) a ventral nearly vertical surface posterior to the quadrate, bearing a well-marked groove for the depressor mandibuli, and curving medially to meet the backward prong of the opisthotic which, as typically in pelomedusids, projects somewhat further posteriorly than the more dorsally placed backward process of the squamosal. Quadrate fully closed behind the columella. A narrow nearly horizontal opening in the cavum tympani leading posteriorly into a posterodorsal squamosal antrum. Below this is the tear-shaped columellar foramen through which the columella dorsally and the eustachian tube ventrally enter the middle ear. In front of the columellar opening (on one side only) is a very shallow depression which may represent the precolumellar fossa frequently present in pelomedusids and chelyids. The side of the temporal region apparently deeply emarginate, and the quadratojugal displaced dorsally. The orbits small, circular, far anterior, smaller than the cavum tympani. The maxilla rather narrow vertically. Indications of grooves marking off a "subocular" scute *sensu* Sieben-

rock, 1902, such as is present in some living species of *Podocnemis*. The premaxillae perhaps forming a hook; if so the hook eroded in the specimen. Nares much broader than high. Two strong ridges on the triturating surface of the maxilla, the ridges uniting anteriorly well short of the premaxilla. A deep premaxillary fossa, broken through in the specimen, implying a strongly hooked mandibular symphysis. The maxillae united behind the premaxillae for a significant distance in an incipient secondary palate. The vomerine region filled with crystal; probably no vomer was present. The ectopterygoid processes typically pleurodiran, moderately developed, and strongly inclined backward. The hypertrophied "carotid channel" smaller than in many *Podocnemis* but clearly specialized in the fashion peculiar to this group within the pelomedusids. The basisphenoid broad, subpentagonal, a long oblique lateral suture between quadrate and basioccipital. The occipital condyle missing in the specimen.

Discussion. It is very easy to show that the skull here named *Dacquemys paleomorpha* cannot belong to the genus *Stereogenys*. The type of *Stereogenys* is *S. cromeri* (U. Eocene of the Fayum) (Andrews, 1906), and the type of that species is a skull that differs more from *Dacquemys* than *Dacquemys* does from some of the species of *Podocnemis sensu lato*. I tabulate the major differences below.

Stereogenys cromeri	*Dacquemys paleomorpha*
Skull very broad, nearly as broad as long	Skull moderately elongate, one and one half times as long as wide
Squamosal not in contact with parietal	Squamosal in broad contact with parietal
Orbits exposed dorsally	Orbits not exposed dorsally
Secondary palate greatly developed, formed by a long median suture of the palatines, the maxillaries not meeting medially or meeting for a short distance only	Only an incipient secondary palate formed by the median union of the maxillaries behind the premaxillaries
Internal choanae therefore well behind the orbits	Internal choanae nearly at posterior level of orbits
Maxillary triturating surface without ridging	Maxillary with two ridges
Pterygoids (*fide* Andrews 1906) conceal basisphenoid ventrally	Basisphenoid exposed ventrally in normal fashion

The differences here summarized and also the great general difference in habitus go far beyond the amount that may be admitted within a genus of turtles. Dacqué was indeed aware of these differences (cf. p. 310 his paper) but he seems to have believed that the generic concept in turtles was founded on shells alone, and therefore that if a skull could be associated with a shell which appeared to be referable to a certain genus, the whole animal must receive the shell name, no matter how aberrant the features of the skull. This is, of course, incorrect. Not only is the type of *Stereogenys cromeri* the highly peculiar skull and not only are the shells which are referred to this genus so referred on grounds which are not conclusive, but even if this were not so, the generic concept in turtles as elsewhere is based on the total animal and not any arbitrarily chosen part of it. Generic distinction rests on the total grade of specialization.

Quite as surely as it cannot belong to *Stereogenys*, the skull here discussed cannot belong to *Podocnemis* or to any other pelomedusid genus in which the skull is known.

From *Shweboemys* (Swinton, 1939) it differs in much the same ways that it differs from *Stereogenys*. From *Podocnemis* in a restricted sense (type *P. expansa* and including only South American species), the Oligocene Egyptian skull is distinguished by the small, strictly lateral orbits and the very broad interorbital width as well as by the squamosal-parietal contact and the absence of a forehead groove.

From both *Erymnochelys* (type and only living species *E. madagascarensis*) and *Peltocephalus* (type and only living species *P. dumeriliana*) it is distinguished by the double rather than single maxillary ridge, by the better developed secondary palate, by the shallowness or absence of a precolumellar fossa as well as by the squamosal-parietal contact and probably also by the lateral emargination of the temporal region.

From *Pelomedusa*, *Pelusios* and *Carteremys* (Williams, 1953), it is sufficiently distinguished by the covered temporal region and especially the squamosal-parietal contact, but from at least *Pelusios* and *Pelomedusa* it differs in the characters which it shares with the *Podocnemis* group of genera, to which it must, indeed, be referred — the enlarged "carotid channel" and the basioccipital-quadrate contact etc. From *Bothremys* (Hay, 1908)

it differs as radically as from *Stereogenys* e.g. in lacking the extraordinary pits in the maxillae so characteristic of *Bothremys*, in the much narrower skull, in the absence of a vomer, etc.

Other genera of fossil pelomedusids are known, but in none of these is the skull known, and there is no plausible reason for ascribing this skull to any of them. But while it is thus easy to show that to place the Egyptian skull in any described genus would be erroneous or probably erroneous on present knowledge, it is impossible to be sure that it does not belong to one of previously described Fayum species based on shells. I incline, indeed, to the opinion that it does belong to one of these species.

From the Lower Oligocene beds of the Fayum from which *Dacquemys* derives, three species of pelomedusid turtles have been described: *Podocnemis fajumensis* Andrews, *Stereogenys libyca* Andrews, and *Pelomedusa progaleata* v. Reinach.

If *Pelomedusa progaleata* (material re-examined by Dacqué, 1912) is correctly assigned and there appears to be sufficient reason to think that it is, *D. paleomorpha* cannot be synonymous with it, since the skulls in the two genera are so very different that they do not belong even in the same subsection of the Pelomedusidae.

Unless the *Dacquemys* skull belongs to some variety of shell still undiscovered, decision must then lie between *Podocnemis fajumensis* and *Stereogenys libyca*. This task is difficult, requiring a rather complex and tenuous argument.

The argument may be stated in this fashion:

The shell of *Podocnemis fajumensis* differs so little from that of Recent *Erymnochelys madagascarensis* that, considering the shell alone, the distinctness of the fossil species might be questioned. The skull of the fossil form might therefore be expected to be very like that of the Recent species, and in fact the *Dacquemys* skull is more similar to the skull of *Erymnochelys* or of related *Peltocephalus* than to any other known pelomedusid skulls. Since it seems evident that skulls in the *Podocnemis* sidebranch of the Pelomedusidae are subject to much more radical modification than the shells, which tend to be conservative and relatively difficult to distinguish, it is a possibilty worth considering that the Dacqué skull may belong to "*Podocnemis*" *fajumensis*.

In the alternative case of *Stereogenys libyca* the shell which is the type of this species is clearly very similar to that referred to *S. cromeri*. The argument that the shells referred to *S. cromeri* really belong to that species is plausible even though not conclusive. Andrews (1906, p. 298) remarks: "Although in no case have the carapace and plastron been found associated with the skull in such a manner as to leave no doubt that they belong to the same individual, nevertheless the shell . . . may be regarded with reasonable certainty as belonging to the present species. In the first place, this form of shell, like the skull, is the commonest occurring in the Qasr-el-Sagha beds, and in the second place it differs widely from the shell of *Podocnemis*, the only other Pleurodiran genus found at this horizon." Accepting Andrews' interpretation of the situation, if *Stereogenys libyca* is really closely related to *S. cromeri*, it should have a skull to some degree resembling that of *S. cromeri*. The Dacqué skull is so very different from that of *S. cromeri* that it is very unlikely to be the skull of *S. libyca*.

Thus the Dacqué skull is unlikely to be that of *S. libyca* and might be that of *P. fajumensis*. But to assert the truth of the latter suggestion confidently would be a bold venture. In the next paper of this series I shall present additional evidence based on a skull from the Miocene of Moghara that this suggestion may possibly be true, but even with this addition the evidence will still be incomplete. It remains an unfortunate fact that with none of the pelomedusids of Egypt is there an unequivocal association of a skull and a shell. I have therefore described the species *paleomorpha* as new, preferring to indicate the present state of the evidence: that we have here a very distinct type of skull which may belong to either of two distinct shell types or possibly to a third unknown one.

Andrews (1906, p. 295) has described from the same beds with *Dacquemys paleomorpha*, *P. fajumensis* and *S. libyca* an anterior portion of mandible which he has referred to *P. fajumensis*. His comment on this element is as follows: "This mandible differs from that of *P. madagascarensis* in having a broader symphysis; the biting surface is also broader and is partially divided in two by a median ridge." Figure 1 is a photograph of this mandibular fragment made by Peter Green and published by permission of

the Trustees of the British Museum. It will be seen that the ridging of this mandible would fit well with the maxillary ridging of *Dacquemys paleomorpha*, but there is no strong hook at the mandibular symphysis such as seems to be implied by the deep premaxillary form of the skull. In this case, as in the previous one, only discovery of associated material can verify the reference to genus and species.

Fig. 1. Dorsal view of mandible referred by Andrews to *Podocnemis fajumensis*. BM (NH) R 3346, from the Lower Oligocene of the Fayum, Egypt. x1. Photograph reproduced by permission of the Trustees of the British Museum.

The photographs of the skull of *Dacquemys paleomorpha* were made by the Museum für Naturkunde in Stuttgart and I am very grateful to the authorities there for the privilege of reproducing them.

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Plate 1. Type skull of *Daequemys paleomorpha*, new genus, new species. Staatliches Museum für Naturkunde, Stuttgart No. 12645. Above: ventral view; below: dorsal view. Photographs reproduced by courtesy of the Staatliches Museum für Naturkunde. x1.

BREVIORA

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PRESENT KNOWLEDGE OF THE SNAKE *ELACHISTODON WESTERMANNI* REINHARDT

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INTRODUCTION

In 1863 Johannes Reinhardt described a peculiar snake belonging to the new genus and species *Elachistodon westermanni*, the specific name referring to the collector, William Westermann, who obtained the initial specimen in Rungpore (Rangpur, see Fig. 1), northeast Bengal. Reinhardt's single specimen was characterized by certain specializations of the integument, by an almost complete absence of teeth, and by certain of the vertebrae bearing hypapophyses which penetrated the esophagus. Comparison with the African snake *Dasypeltis*, long known to be specialized for egg-eating by a similar series of modifications, was inevitable, and Reinhardt came to the conclusion that *Elachistodon* was also an egg-eater. Differences between *Elachistodon* and *Dasypeltis* centered about minuscule grooved teeth and an enlarged row of dorsal scales in the new genus. The presence of the grooved teeth on the posterior aspect of the maxillae suggested the placement of the form in the composite section Opisthoglypha, but Reinhardt pointed to the close similarity between this form and the aglyphous *Dasypeltis* as evidence for the artificiality of this category.

Since 1863 only four additional specimens have been reported and there has been little additional contribution to the morphology or natural history of the species.

A recent study (Gans, 1952) has demonstrated a number of previously undiscussed modifications in *Dasypeltis* and has shown that this genus is much more highly adapted to its very special mode of life than had previously appeared to be the case.

In view of this new knowledge of *Dasypeltis* it was felt that a re-examination of the status of *Elachistodon* would be especially

Fig. 1. The distribution of *Elachistodon westermanni*. Crosses mark the localities where specimens were found.

appropriate at this time. Unfortunately, however, the existing specimens are too few to permit a detailed investigation such as was carried out for *Dasypeltis*. It has, indeed, been possible for one of us (Williams) to make an examination of the specimen in the British Museum and of the osteological preparations from that specimen figured and referred to by Malcolm Smith (1943, p. 403), but the information so derived is suggestive rather than adequate, and it is very evident that further specimens will be needed for thoroughgoing anatomical studies.

This paper, therefore, has two objects. First, it is intended to provide a recapitulation of the existing data on *Elachistodon* in the light of the findings in the genus *Dasypeltis*, and secondly it is desired to reawaken interest in *Elachistodon* in the hope of obtaining the additional specimens upon which the more intensive studies might be based.

HISTORICAL RESUMÉ

The initial specimen was rather fully described by Reinhardt (1863, p. 198), whose careful investigation of its internal anatomy was undertaken because the enlarged vertebral scales of the new form had left him in doubt as to its taxonomic placement. He prepared the tooth-bearing elements of the right side of the skull and one of the mandibles, and checked the condition of the vertebral hypapophyses and their relation to the esophagus without dissecting out the vertebrae or separating them. He found teeth on both palatine and pterygoid as well as teeth and minuscule fangs on the maxilla and described the shape and appearance of the dentary. In comparing *Elachistodon* with *Dasypeltis* he pointed out that in both there were two types of penetrant hypapophyses, though both types in the new form were less well-developed. He figured the palatal and mandibular elements of both genera (see Fig. 4).

The stomach and gullet of the type specimen of *E. westermanni* were found to be filled with an amorphous congealed mass which analysis indicated might be either milk or egg fluid. Though he did not find shell fragments mixed in this mass, Reinhardt speculated on the feeding habits of the animal and appears to have leaned toward the theory that the species was an egg-eater.

Reinhardt also described in detail the squamation of *Elachistodon*, mentioning the very peculiar deep pit on the posterior nasal as well as similarities to *Dasypeltis*. Further details on these and other structural points will be presented in the discussion of the morphology of *E. westermanni*. Reinhardt placed the new genus in the family Rachiodontidae (*sic*).

The next to refer to *Elachistodon* was Günther (1864, p. 444) who mentioned it on Reinhardt's authority only. He suggested that the genus should be separated as a distinct group of colubrids.

Blanford (1875, p. 207) reported the second specimen from Bihar, Purnea (see Fig. 1), and his general description agreed with that of Reinhardt. He suggested that the genus be referred to the Dipsadidae.

Cope (1886, p. 494) considered only the familial assignment of the genus, placing it in the subfamily Dasypeltinae with *Dasypeltis*.

Boulenger in the Fauna of British India (1890, p. 362) placed the genus in the Opisthoglypha, Dipsadinae, next to *Dipsas*. He stated that he had not been able to examine specimens but from the key (pp. 356-357) it appears that the assignment was based on the grooved teeth, the enlarged vertebral shields and the elliptically vertical pupil. He also referred to esophageal teeth capped with enamel.

Sclater (1891, p. 48) in listing the snakes in the Indian Museum recorded a specimen from Bengal which seems to have been that earlier recorded by Blanford. He placed it in the Dipsadinae.

In the Catalogue of the Snakes of the British Museum, volume 3, Boulenger (1896, p. 263) erected the subfamily Elachistodontinae of the Colubridae with the single genus *Elachistodon*. He regarded this as the opisthoglyphous analogue of the aglyphous Rachiodontinae. His description of the subfamily mentions pterygoid teeth.

The next record is that of Wall (1913, p. 400) who reported a new specimen from the Jalpaiguri district (see Fig. 1) and published a detailed comparison of the three specimens then known. He did not give the sex of the third specimen (it is, however, the female described again by M. Smith, 1943) but did cast doubt on the presence of pterygoid teeth. His later 'Handlist' (1923, p. 878) did not contain any new data.

In a serialized discussion of the snakes of northern Bengal and Sikkim, Shaw, Shebbeare and Barker (1941, p. 65) list the specimens known to them. In addition to the original Rangpur specimen in the Museum at Copenhagen they cite a second from Purnea (the Blanford specimen) in the Indian Museum at that time. The specimen obtained by Travers at Jalpaiguri (Wall, 1913) was stated to be in the Bombay Museum (it is now in the British Museum), while the then whereabouts of two addi-

tional specimens obtained by Travers at Baradighi[1] appeared to be unknown.

Malcolm Smith (1943, p. 403) redescribed the genus and removed it from the Elachistodontinae to the Dasypeltinae. He presented the first published figures of the modified vertebrae and also refigured the palatal bones. Pterygoid teeth are not mentioned in his text or shown in his figure.

Smith and Bellairs (1947, p. 362) mention only that the Harderian gland is enlarged in this form as in *Dasypeltis*.

MORPHOLOGY

General

The following condensed diagnosis is designed to aid identification of specimens. For this reason it follows the summary presented by Smith (1943, p. 404) with only minor modifications.

Head fairly distinct from neck; eye large with vertically elliptical pupil (round *fide* Reinhardt); a large pit in the posterior part of the nasal shield. Body moderately elongate, feebly compressed. Tail short, subcaudals paired.

Internasals as large as prefrontals; frontal large, longer than its distance from the end of the snout; nasal large; 1 small preocular, the loreal below it entering orbit; two postoculars; two long anterior temporals; 6 or 7 supralabials, the third and fourth touching the eye; 2 pairs of sublinguals. Scales smooth, in 15 rows, 19 on the neck, the vertebral series much enlarged, hexagonal. Anal single. Ventrals 208-217. Caudals 59-65.

Above, dark olive brown to blackish, the vertebral scales yellowish-white, except at their outer margins, forming a light vertebral stripe extending the whole length of the body; sides spotted or flecked with the same color; whitish below, the outer margins of the ventrals and adjacent rows of scales edged with brown; a yellow stripe along the top of the head from the snout to the angle of the mouth, passing above the eye; an angular bar or spot on the nape; lips yellow.

♀ 784 mm. (670 + 114 mm.). Ventrals 217. Caudals 59. Rungpore, Bengal. Copenhagen Museum (Reinhardt).

[1] We have been unable to find Baradighi on any map, but the Indian Consular Office in New York has very kindly informed us that there is a railroad station by that name about 30 miles north of Calcutta.

♀ 800 mm. (670 + 130 mm.) *fide* Smith, (762 mm. [635 + 127 mm.] *fide* Wall). Ventrals 213 (210). Caudals 62 (64). Near Mal, Jalpaiguri District. Formerly Bombay Museum, now British Museum (Natural History).

? 222 mm. (186 + 35.7 mm.), Ventrals 208. Caudals 63. Bihar, Purnea. Indian Museum (Blanford).

Fig. 2. *E. westermanni.* Oblique view of the head of the British Museum specimen to show the expansion lines between the lower labials at the angle of the mouth.

Squamation of Head and Neck

The most significant integumentary similarities between *Elachistodon* and *Dasypeltis* are the structure and arrangement of the gular and cheek scales. This similarity was already pointed out by Reinhardt who, however, did not know the function of the parallel structures. The fact that in *Dasypeltis* these gular and cheek specializations have been definitely shown to be elaborate adaptations for egg-eating suggests that the possession of similar structures by *Elachistodon* is correlated with similar habits.

In both *Elachistodon* and *Dasypeltis* there are two pairs of sublinguals closely joined and lacking any evidence of the median groove that in most snakes provides for expansion. In *Dasypeltis*

there are no true gular scales at all, while in *Elachistodon* there is but one row of these. In both of these forms the sublinguals are so rigidly tied in that expansion of the chin region can only take place along the angle of the mouth during ingestion. In *Dasypeltis* this expansion is made possible by the presence of extremely distensible skin between the scales of this region. The last labials have also been rearranged to form the first scales of the lowest lateral rows. The same condition is also the case in *Elachistodon*, and the resulting lines of expansion are clearly seen in Figure 2. Such a specialization, the value of which is probably solely restricted to egg-eating, would tend to furnish additional evidence for the idea that other described modifications of *Elachistodon* are adaptations to this habit.

A possibly significant point of difference between *Elachistodon* and *Dasypeltis* is the presence in the form of a large pit on the posterior part of each nasal shield. The function of similar pits in the Crotalidae as well as in certain species of Pythonidae has been determined to be that of a thermosensitive range-finder (Noble and Schmidt, 1937), and it is known that similar structures of as yet uninvestigated function exist in other forms. In *Elachistodon* nothing is known of the function of the pits.

Squamation of the Posterior Body

The enlargement of the vertebral series of dorsal scales characteristic of *Elachistodon* is a feature also found in a large number of dipsadine and other snakes but not in *Dasypeltis*. Little is known about the function of this enlargement although Peters (MS 1952, p. 27) has speculated on its relation to the arboreal habits of the dipsadines. He believes that in conjunction with the extreme lateral flattening of the body it might impart a stiffening effect. He offers the analogy of an I-beam, and suggests that the enlargement of the vertebrals might permit the unusual horizontal rigidity and extension observed in climbing members of the Dipsadinae. We cite the suggestion here without passing judgment upon its applicability to *Elachistodon*, which shows but feeble lateral compression.

It is also to be noted that the scales of *Elachistodon* are smooth while those of *Dasypeltis* are strongly keeled. This character is, however, of little value at the generic level or above, in view of

the number of cases in snakes in which it shows intrageneric variation.

Elachistodon exhibits no trace of the size reduction, angling and serration exhibited by the second to sixth rows of dorsal scales in *Dasypeltis*. Except for the vertebral row all the dorsals are uniform in size and character.

Soft Tissues of the Head

No published observations are available on gum structure. Examination of the British Museum specimen indicated that the gum ridges are probably covered with a somewhat less convoluted mass of tissue than are those of *Dasypeltis*.

Smith and Bellairs (1947, p. 362) have noted that the Harderian gland is notably enlarged in *Elachistodon* paralleling the condition in *Dasypeltis*.

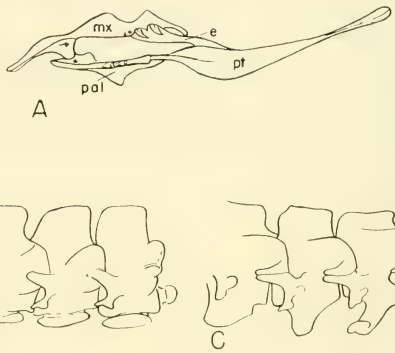

Fig. 3. *E. westermanni*. *A*, Palatal bones; *B*, anterior hypapophysial vertebrae; *C*, posterior hypapophysial vertebrae. Abbreviations: *e*, ectopterygoid; *mx*, maxillary; *pal*, palatine; *pt*, ptergygoid. After Malcolm Smith (1943).

Skull

To the best of our knowledge no complete skull has ever been prepared. The palatal elements have been figured by Smith (1943) (see Fig. 3, A). A check of the material by one of

us (Williams) found the figures accurate in all particulars including the fact that pterygoid teeth (described and illustrated by Reinhardt in the Copenhagen specimen) are not to be seen.

Comparison with the homologous elements in *Dasypeltis* indicates few differences beyond the presence of the relatively enlarged grooved teeth on the posterior aspect of the maxilla in *Elachistodon*. This portion of that bone is also somewhat more strongly developed and there are general though minor differences in the relative proportions of the various structures. The union between palatine and maxillary may be somewhat weaker than the corresponding articulation in *Dasypeltis*. The wing-shaped process of the palatine is much abbreviated though this process is shown as greatly extended in Reinhardt's drawing. These bones are, however, very fragile, and it may be possible that some of the apparent differences may be traced to the method by which these elements were cleaned. The similarities seen lead us to the conclusion that the palatal elements of *Elachistodon* are as rigidly joined as those of *Dasypeltis*.

The dentitional formulae are as follows: Maxilla edentulous except for two small teeth followed by two larger grooved teeth; palatine with four minute teeth in its center; pterygoid — according to Reinhardt — with three extremely minute teeth. Wall (1913) and Smith (1943) — both treating of the specimen from Jalpaiguri — do not refer to pterygoid teeth. The dentary has eight to twelve teeth diminishing in size posteriorly.

Reinhardt has figured and described the anterior end of the mandible for both *Elachistodon* and *Dasypeltis*. The appearance of the element in *Elachistodon* is very strange, and since the figure of the same element in *Dasypelt's* bears very little resemblance to actual specimens seen by us, we do not care to comment further in this matter (see Fig. 4).

Vertebral Column and Esophagus

There are certain rough similarities in the appearance of the anterior vertebrae (hypapophysials) in the two forms. In both there are two basic types of hypapophyses — anterior and posterior, but in *Dasypeltis* some of the anterior hypapophyses undergo considerable ontogenetic variation so that it is best to distinguish anterior, intermediate, and posterior types. It is not known

whether similar ontogenetic variation is found in *Elachistodon*. For the latter genus, therefore, these comments must of necessity be restricted to the modified vertebrae of the adults.

In *Dasypeltis* the anterior hypapophyses are little modified. They are of the "normal" squarish shape with only their ventral edges enlarged into sled-like runners. The egg glides along these runners during ingestion, but the runners do not serve any cutting or sawing function. The egg is pierced by the elongate, spiniform, forward pointed hypapophyses of the posterior series, which penetrate the esophagus in all specimens (Gans, 1952, p. 236). After the shell has been broken, the heavy rounded boss-like hypapophyses of the intermediate series transmit a crushing force to the egg shell and fold this, while the egg contents are being squeezed into the stomach through the esophageal valve. The forces involved in this action are sizable, and for this reason the articulating surfaces of the neural arches are greatly expanded, the pre- and postzygapophyses being laterally displaced and extended by spiniform processes. This offers additional surface for the action of the dorsal musculature which is kept from lateral slippage by the confining inclination of the surfaces of attachment.

The intermediate and some of the anterior hypapophyses are penetrant in adults of *Dasypeltis*, but this character shows considerable variation in juveniles. There is also evidence that some seasonal variation of this character may occur in adult specimens as well.

In *Elachistodon* nothing appears to be recorded about the hypapophysial vertebrae immediately posterior to the cervicals, and these have never been figured. Perhaps it may be assumed that they are of "normal" appearance, possibly performing the same function as do the homologous structures in *Dasypeltis*. There is no record as to the number of these "unmodified" vertebrae, though Smith (1943, p. 403) states that the modified hypapophyses start opposite the tenth ventral shield.

The amount of skeletal preparation which has been done for this region is very limited. Reinhardt (1863, footnote to p. 202) stated that he had not skeletonized but rather examined the vertebral column *in situ*. Smith figures two short sections of three vertebrae each (Fig. 3, B and C). One of us (Williams)

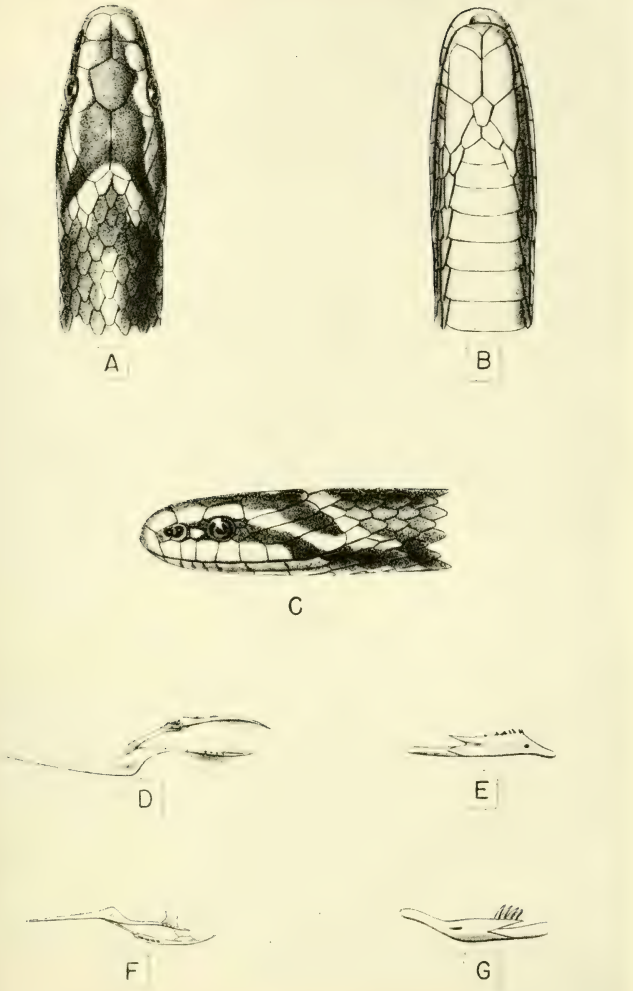

Fig. 4. Plate from the original description by Reinhardt. *A*, *B*, *C*, Dorsal, ventral and side views of the head of *E. westermanni; D*, palatal bones of *E. westermanni; E*, dentary of *E. westermanni; F*, palatal bones of *Dasypeltis scaber; G*, mandible of *Dasypeltis scaber.*

has examined these vertebrae, and the following statement is based on this examination.

The more anterior of the prepared and figured hypapophyses are very strange in appearance. Bosses are present as in the intermediate hypapophyses of the African form, but they are not as closely integrated with the base of the centrum. They are instead mounted on a pedicel beyond which they extend both anteriorly and posteriorly. The vertebrae bearing these hypapophyses are relatively undifferentiated. No extension or inclination of the zygapophysial surfaces is apparent.

In some ways the anterior hypapophyses of *Elachistodon* are reminiscent of stages in the ontogeny of the intermediate hypapophyses in *Dasypeltis*, though the mounting on a pedicel suggests that they may be specialized in a different direction. Reinhardt (1863, p. 203) stated that there were nine such anterior hypapophyses, while Smith (1943, p. 403) counted eighteen all of which projected through longitudinal slits into the esophagus. Both authors believed that these are cutting instruments, which hardly seems likely in view of the findings in *Dasypeltis*.

Compared to the posteriormost hypapophyses in *Dasypeltis* which are such highly effective tools, these same elements in *Elachistodon* seem even less modified than the anterior hypapophyses. In *Elachistodon* the hindmost hypapophyses are block-shaped spines whose major specialization lies in the fact that they are directed forward rather than backward. They most nearly resemble the hypapophyses of several of the species of *Elaphe* recently mentioned as being specialized for egg-eating (Gans and Oshima, 1952, p. 15), but they also resemble those hypapophysials of very young *Dasypeltis* that are transitional between the intermediate and the posterior series.

Reinhardt speaks of thirteen of the posterior type hypapophyses in *Elachistodon*, with only the first ten penetrating the esophagus, while Smith mentions eight of these structures, none penetrating the esophagus. Smith's observation would of course be in strong contrast to the findings in *Dasypeltis*, and the contradiction in observations here makes it quite clear that the egg-eating habits of this form will have to undergo a separate analysis to determine the extent to which parallelism in function exists, and to explore the differences.

In spite of this, it may be stated that all indications exist that eggs are opened by *Elachistodon* in a manner similar to that employed by *Dasypeltis* and *Elaphe climacophora*, i.e. by exerting a force concentrated by the processes of the vertebrae.

A comment may be made on Smith's Figure C (our Fig. 3 C). The third figured hypapophysial carries a hypapophysis with what appears to be a shovel-shaped tip. While the drawing is entirely accurate, its two-dimensional nature does not do the subject justice, as this tip is actually deformed into a hook in the horizontal plane in a most peculiar manner. The asymmetry and other features of the structure make it obvious that this is merely an individual aberration of no adaptive or other significance. Similar variations occur on the hypapophyses of a number of other oophagous and non-oophagous species of snakes examined by us.

Finally it may be well to mention that the hypapophyses in *Elachistodon* are formed of very dense bone only and do not consist of enamel as stated by various authors. While it has not been possible to undertake histological studies for this form, detailed and repeated investigations have shown this to be true for *Dasypeltis* (Gans, 1952; Gans and Oshima, 1952), and no evidence exists which might permit the contrary conclusion in *Elachistodon*.

BIOLOGY

No specimen of *Elachistodon* has ever been kept in captivity and there exist no notes on habits or habitats in the wild. With the exception of Reinhardt's specimen which had egg yolk (?) in its stomach, no other observations on stomach contents have been published. The concensus of the literature (based on no direct evidence) is that the form eats "eggs but not exclusively." The presence of grooved teeth and the nasal pit suggest that the species may feed also on live and homoiothermous prey.

The only other item of interest concerns breeding habits. The type was a gravid female, containing seven (40 x 11 mm.) eggs (Reinhardt, 1863, p. 210). None of these contained embryos although they were already covered with a relatively heavy shell. This would indicate that the species is oviparous as is also true for *Dasypeltis*.

Comparison of *Elachistodon* and *Dasypeltis*

The following tables sum up the more important similarities and differences — at present known — of the two genera.

Points of Similarity

Sublingual shields fused, mental groove absent; special provision for expansion of the skin along the angle of the mouth and in the cheek region; Harderian gland much enlarged; palatal elements modified, largely edentulous, with teeth present only on the posterior aspects of maxilla and palatine; ? upper jaw elements rigidly tied together; teeth on posterior aspect of dentary only; a loose articulation between dentary and compound bone. Vertebral hypapophyses modified, some penetrating the esophagus; anterior hypapophyses generally rounded, with sledge-like runners or bosses; posterior hypapophyses developed as forward-pointing spines; oviparous.

Points of Difference

Dasypeltis	*Elachistodon*
Nasal pit absent	Nasal pit present
No gulars	One row of gulars
Scales strongly keeled	Scales smooth
Vertebral scale row subequal to dorsals	Vertebral scale row enlarged
Some lateral rows with scales reduced in size, inclined and with serrate keels	All lateral rows with scales of equal size
Maxillary teeth minute and equal	1-2 enlarged grooved teeth on rear of maxilla
Intermediate hypapophyses heavy, rounded, boss-like, closely applied to centra	Bosses of hypapophyses separated by constriction from centrum, i.e. mounted on pedicel
Posterior hypapophyses bear sharply pointed spines and penetrate esophagus	Posterior hypapophyses much less strongly developed, ? no penetration
Eliptical pupil	? Round pupil (*fide* Reinhardt)
No pterygoid teeth	? Pterygoid teeth (*fide* Reinhardt)

Inspection of the above lists reveals that the similarities between the two forms are primarily those of structures which in *Dasypeltis* are known to be connected with egg ingestion. Many of the differences are at a level generally associated with a generic separation, while only the nasal pit and the grooved fangs might indicate a higher level of difference.

It has been suggested that *Elachistodon* may be a less specialized form than *Dasypeltis* but derived from a common ancestral stock that may have been opisthoglyph or even proteroglyph. According to this, greater specialization in *Dasypeltis* has brought about the total loss of the fangs as well as the additional modifications exhibited by this genus. Analysis of the relationships of the genus *Elachistodon* may indeed yield evidence shedding light on the general problem of the origin of the opisthoglyphs.

Beyond the two genera which have been compared here, analysis will have to be carried forward for the various other forms known or suspected to be specialized egg-eaters before it will be possible to determine whether we are dealing with a single series or a set of parallel modifications in separate lines.

It is to be borne in mind that we have here reported for the most part the observations of others and have had little opportunity to check these against actual specimens. It may well be that careful examination of a large series of specimens would force a revision of our understanding of the morphology of *Elachistodon*. This is particularly likely in view of the high amount of variation exhibited by the much better known *Dasypeltis*. The many points of difference noted from the scanty literature testify only too clearly that a similarly high amount of variation is present in *Elachistodon*. It would obviously be dangerous to speculate at this time on the larger problems offered by the Indian genus.

In view of this dearth of knowledge and the high interest of the Indian genus, the authors wish to urge local zoologists or anyone whose work may take him into the range of this form to secure us specimens. Any such material may be sent to either of our institutions. Credit will of course be given in any subsequent reports.

Acknowledgments. Our thanks are due to a considerable num-

ber of people with whom phases of the problem were discussed. We wish to express our thanks also to Dr. H. W. Parker, Mr. J. C. Battersby and Miss A. G. G. Grandison of the British Museum (Natural History) for assistance there and for permission to examine their specimen of *Elachistodon*. We are indebted also to the authorities of the University of Michigan Museum of Zoology for the use of library facilities while in Ann Arbor.

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BREVIORA

Museum of Comparative Zoology

CAMBRIDGE, MASS. AUGUST 18, 1954 NUMBER 37

ON THE EVOLUTION OF AN ORIENTAL EARTHWORM SPECIES, *PHERETIMA ANOMALA* MICHAELSEN 1907

By G. E. GATES

Most individuals of this aptly named species are referable to three formae, though large collections usually have contained one to several individuals regarded as intermediates. F. *centralis*, in most localities much the rarer of the three, differs significantly from the generic pattern only in location of the male pores on xx. F. *typica*, the first to be found, is athecal and additionally distinguished from *centralis* by extra pairs of testes and male funnels in v-ix, frequently even supernumerary gonads in those segments, as well as by extra pairs of mushroom-shaped glands in one or more of segments xxi-xxiv. F. *insolita* is thecal, each organ of the battery normal and the pores on 5/6-7/8 as in *centralis*, but lacks the mushroom glands and the male genital terminalia.

According to the first attempt at explaining the origin of these differences, f. *typica* and f. *insolita*, are respectively male and female secondarily evolved from the normally hermaphroditic *centralis*. In spite, however, of the presence of testes in unusually large numbers, sperm are not matured in the supposed males. On the contrary, sperm are produced by the supposed females even though discharge of the matured gametes from the body seems to be impossible.

According to a second explanation, the two divergent forms result from selective inhibition of secondary sex organs, during post-hatching development, by metabolic products released from two different types of protozoan parasites. Before an opportunity could be found to study results of activities of the parasites that

obviously are present in such large numbers in the aberrant forms of this and also other species of *Pheretima*, data from other sources began to indicate the necessity for another explanation.

P. anomala has now been found in several widely separated localities in India to which it has been transported from its proper home somewhere to the east of the Irrawaddy River. Only f. *typica* was secured at each of those localities. Presumably then, this form breeds true. This assumption is also supported by the incidence of the various formae in certain localities in Burma, as for instance in the Kamaungthwe River region of Tavoy district. In two collections from that area, taken two months apart, *centralis*, *typica*, *insolita* and the intermediates were represented by 0+0, 377+69, 11+2, and 31+8 specimens respectively. The intermediates, in most of these cases, would be referable to a less strictly defined *insolita* as they were distinguished only by the possession of one or more of the mushroom glands characteristic of *centralis* and *typica*.

F. *insolita* has not been found as yet in complete isolation, but its incidence is high in some localities. One collection from Taungyi, in which *centralis*, *typica*, *insolita* and intermediates were represented by 7, 32, 293 and 3 specimens respectively, also suggests a possibility of a true-breeding form. Here again the intermediates were referable to a less strictly defined *insolita*.

F. *centralis* never has been found in isolated colonies. It usually can be secured in most localities in Burma if search for it is continued long enough. Incidence always has been low, the greatest, according to the records now available, about 20 per cent, in a Karenni collection (from Koopra) in which the formae were represented, in order as above, by 21, 5, 67 and 9 specimens. Geographically, Karenni quite possibly is nearer the region where *anomala* may have arisen.

Throughout the Burmese portion of its range, *P. anomala* now seems to have been largely segregated into true-breeding forms. This could have been brought about, in earthworms, through replacement of sexual by parthenogenetic reproduction. As sperm are not produced by f. *typica* and since it lacks the organs for reception of male gametes from another individual, it can be assumed to reproduce parthenogenetically. In f. *insolita*, though sperm are produced, they cannot be discharged during copulation

and few individuals are likely to have an opportunity to copulate with those that can. No good evidence has been found for self fertilization. Presumably then, these supposed females, like the "males", usually do not reproduce sexually but parthenogenetically.

Evidence for copulation of individuals of different formae cannot now be presented due to destruction of the records during World War II. Copulation between individuals of *typica* certainly would appear to be futile. Cross copulation between individuals of *isolita* and *typica* would have no result for the *typica* worm, and the *insolita* partner ordinarily would receive into its spermathecae only secretions from the unusually well developed prostate glands of the *typica* individual. The opaque and non-iridescent coagulum often present in spermathecae of clitellate specimens of *insolita* may have been prostatic secretion received from a *typica* worm though the same non-iridescent opacity can eventuate from resorption of sperm in the seminal fluid received from another sort of partner.

Copulation in the cross *insolita* x *centralis* would not even result in transfer of prostatic secretions to the spermathecae of the normally sexual *centralis* individual which would then have to reproduce, if at all, by self fertilization (unlikely) or by parthenogenesis! In the latter case, offspring of the *centralis* type would be expected. The *insolita* partner, normally parthenogenetic, would however receive *centralis* sperm and unless parthenogenesis had become obligatory could be expected to reproduce sexually!

Copulation between two individuals of *centralis* can be expected to result only in *centralis* offspring but in view of the rarity of this form throughout most of Burma the cross can be expected there only infrequently.

A majority of the so-called intermediates resemble *insolita* except for the presence of one or more mushroom glands. Such anarsenosomphic worms can be expected to reproduce in the same way as *insolita*. The intermediates with male genital terminalia on one or both sides of the body can be expected to reproduce in the same way as *centralis*.

Of the 99 intermediates from the collections that were made throughout Burma during 1928-1932, 96 were assumed, because of their structure, to show relationships to both *insolita* and *cen-*

tralis, the only forms which can be expected, according to the preceding discussion, to produce offspring from a hybrid cross. Of the 96, 71 were without male terminalia like *insolita* and 25 had male terminalia as does *centralis*. This looks like a good approximation to the expected ratio in the F_2 generation if "*insolita*" is dominant to "*centralis*". The Mendelian relationship, if such it be, is however recognizable only because the mushroom glands of *centralis* have been carried over into the *insolita* phenotype. The *centralis* phenotype likewise was aberrant as prostates were variously located in segments xix-xxi, or only their ducts were present, or only one prostate was present, while mushroom glands always were lacking in xvii-xix and when present were in the segment where prostates should be expected.

The three remaining intermediates were thought to show relationships to *typica* and *centralis*. Possibly three of the 528 specimens that were identified as *typica* during the same period should also have been included. Each of these six worms had testes and male funnels in some or all of v-ix as in *typica* but three had a single normal *centralis* (or *insolita*) spermatheca and a fourth had a rudimentary one concealed within the parietes. The external aperture of one of the normal spermathecae was on 8/9 and this is the only instance that has been recognized in *anomala* of a pore at that posterior level. Offspring cannot be expected of a cross between *typica* and *centralis*, according to a previous portion of this discussion, and the mass of material collected subsequent to 1932 in the hope of clarifying the relationship was destroyed during the war. However, it can be said that an occasional individual of *typica* showed in seminal vesicles and/or testis sacs rather dubious evidence of having produced a few sperm. Hence, rarely, a cross between *typica* and *centralis* or even *insolita* may be possible. As the latter two are both thecal, presence of spermathecae would provide no clue as to which of the two forms had been involved in the hybrid parentage. If the hybridization is possible, the six cases just cited would seem to indicate that "*typica*", i.e., extra testes and male funnels, is dominant over "spermathecae" i.e., "*centralis*" or "*insolita*".

P. anomala must have arisen, presumably somewhere to the east or southeast of Burma, from an ancestor that may have had mushroom glands, or an equivalent, but which did have the male geni-

tal terminalia in xviii, as throughout most of the genus *Pheretima*. The evidence provided by aberrant individuals of this and other species agrees in indicating that transfer of capacity to develop prostate glands, from one segment to another, whether anteriorly or posteriorly, takes place in a single step rather than by the much more gradual sort of migration that has been assumed in the classical oligochaete phylogeny. An early, if not the first step, in the evolution of *anomala* was then the establishment of a mutation for transfer of prostate developing capacity from xviii to xx. No difficulty is to be expected for the male deferent ducts in reaching the new segment through which they must now open to the exterior, as numerous specimens of *insolita* have shown that the ducts can grow back as far as xxx behind which level male pores very rarely have been recorded in any family of earthworms. F. *insolita* also demonstrates that the male deferent ducts do not acquire an external aperture in absence of the prostates. Union of male deferent and prostatic ducts, regardless of the segment in which the glands are located, suggests that the former, on reaching the prostatic segment, are attracted towards the growing glands. Union presumably takes place at parietal level. Subsequently the prostatic duct ectal to the junction becomes much elongated, carrying the region of that junction deep into the coelomic cavity. In aberrant individuals without prostate glands but with well developed muscular prostatic ducts there is no distinct level of demarcation between the latter and the deferent duct. The gradual transition from one to the other suggests that premature union of the ectal end of the deferent duct with the ental end of the prostate rudiment, instead of at the side, may have had something to do with absence of the prostate gland.

Shortly after establishment of the translocation mutation, appearance of another one may be assumed, this time for permissive or facultative parthenogenesis. Due to the ability of a single individual to reproduce when a copulatory partner was unavailable, the species may have been able to colonize new areas much more rapidly than would have been possible otherwise. Certainly, *P. anomala* has spread through most of Burma, probably to a greater extent than any other species of the genus.

From the steady increase in number of earthworm species, in various families, that are being found to have uniparental repro-

duction, a parthenogenetic mutation appears to be fairly common. Though recognized in *anomala* hitherto only in association with additional mutations to be mentioned below, conditions in other species indicate that they can be independent of each other. Thus, in forms like *P. diffringens* (Baird) 1869, which is now widely spread throughout the United States, reproduction usually seems to be parthenogenetic in spite of presence of a complete battery of normal spermathecae and of normally developed male genital terminalia.

If now a third mutation, "athecal", inhibiting development of the spermathecae, were to arise in *anomala* at the appropriate time, establishment of a true-breeding line would be expected. As the athecal individual could not receive sperm from a copulatory partner, all of its own offspring would be mutants. Offspring of a normal copulatory partner would be in part athecal also and if the mutation is dominant its rapid spread through the population should be possible.

The athecal mutation also seems to be standard as the condition has appeared in individuals of species belonging to various families but with especially annoying frequency in the genus *Pheretima*, depriving the taxonomist of a whole set of the very organs most useful for his species identifications. The mutation has not been found, in other species of the genus, in association with extra testes. To obtain f. *typica* from a *centralis* ancestor, yet another mutation, "testis", is postulated. This too may prove to be standard as extra testes anterior to the usual gonad series already have been found in species of two other families. If this spawning of hypothetical mutations in a single line is to end here it is necessary to conclude that mutation "testis" is not of the apparently simple type of mutation "athecal". In addition to bringing about development of extra gonads and adding two or more pairs of mushroom glands to the *centralis* series it inhibits production of sperm by any of the gonads.

To get f. *insolita* from an ancestor like *centralis*, a mutation, "aprostatic", for inhibition of development of prostates, is required. This condition also appears throughout prostate-possessing families of earthworms but has been noticed more often in the genus *Pheretima*. Unless another mutation is to be postulated it must be assumed that "aprostatic" also expresses itself by

inhibition of development of the mushroom glands. For such an assumption a certain amount of evidence is provided by aberrant individuals in other species of the genus.

Mutations "athecal" and "aprostatic" have not yet been found in the same individual of *anomala* but the two conditions have appeared simultaneously in individuals of other species in the genus, thus depriving the sorely tried taxonomist of the last sets of organs required for species identifications. Association of the two mutations already has been found in at least one of the dozen species of *Pheretima* that have been accidentally introduced into this country.

Another hypothetical mutation, "aseptal", has long been established in *anomala*, as well as in many other species of the genus. This partially or completely aborts, during embryonic development or post-hatching growth, the transverse partition separating the coelomic cavities of segments viii and ix. Abortion rather than inhibition is indicated by persistent rudiments of varying size while incomplete or delayed penetrance is shown by occasional individuals in which a considerable portion of the septum is still recognizable or in which the partition even has become muscular. Yet another mutation, "uniporal", which has been involved in the ancestry of most species of *Pheretima*, results in union of the paired oviducts within the parietes so as to open to the exterior by a single, median pore. Here again, incomplete or delayed penetrance is suggested by the failure of the oviducts, in an occasional individual, to unite ectally thus resulting in a reversion to the ancestral condition with paired female pores.

Postulating a mutation capable of bringing about addition of five pairs of testes, along with five pairs of male deferent ducts — in one step — can be avoided in two ways at least. One alternative would be to assume that a mutation for addition of one or two pairs of testes at the anterior end of the existing series was repeated an appropriate number of times. Repetition of four different one-step-at-a-time mutations now seems to be required in the phylogeny of another genus currently under examination. Another alternative is provided by the widely accepted evolution of the Oligochaeta from marine Polychaeta during which diffuse germinal tissue was strictly concentrated into one intrasegmental location, within the septa close to the nerve cord, but in several

consecutive segments. Nine or ten pairs of gonads almost seem to be required in oligochaete phylogeny by the families of Microdrili. Anlage of such gonads laid down early in embryonic development of *anomala*, instead of being aborted throughout most of the series as usual, could be permitted by mutation "testis" to develop into a macroscopic discoidal stage. Origin of supernumerary gonads in some of the segments can be attributed to early embryonic fragmentation such as breaks a first nephridial rudiment into early components of the enteronephric excretory system in this same genus. Development of male funnels is however induced by the adjacent growing gonads. If the induction effect is adequate, anlage not only become plicate funnels but develop ducts which may even become continuous with those of the posterior segments.

Summary

Evolution of an advanced species from a more generalized generic type and segregation within that species of three true-breeding formae is attributed to the establishment of single effect and multiple effect mutations. Each of these postulated mutations is of a standard sort, required by conditions in aberrant individuals appearing in species of several genera, or by phyletic developments that obviously have taken place in genera of different families.

BREVIORA

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ONNIA (TRILOBITA) FROM VENEZUELA

BY H. B. WHITTINGTON

In 1938 Leith described a Middle Ordovician fauna from the Venezuelan Andes which included the graptolite *Dicranograptus*, a cryptolithinid trilobite, and fragmentary brachiopods and pelecypods. Recently I received several specimens of the trilobite collected from the original locality by Dr. G. R. Pierce, of the Creole Petroleum Corporation, and sent to me by Dr. V. D. Winkler and Mr. K. F. Dallmus, also of the Creole Petroleum Corporation. I am deeply indebted to these gentlemen, and to the Creole Petroleum Corporation for presenting the specimens to the Museum of Comparative Zoology, and for permitting me to publish this note on them. Dr. Karl M. Waagé, Yale University, kindly loaned the original specimen described by Leith.

The new material enables a more complete description to be given, and shows that the species is related to contemporary British, central and southern European, and North African forms, rather than to North American ones. The terminology is that previously employed (Whittington, 1940), with the additions of Stäuble (1953).

Family TRINUCLEIDAE Emmrich, 1884
Subfamily CRYPTOLITHINAE Whittington, 1941

Genus ONNIA Bancroft, 1933
ONNIA TERRYI (Leith, 1938)
Pl. 1, figs. 1-7

Holotype. Peabody Museum of Natural History, Yale University, no. 15317, from Caparo-Bellavista Series, "first hill outside the Capar[r]o River floodplain, about three-quarters of a mile south of the river, along the trail between Santa Barbara (State

of Zamora) and Mucuchachi (State of Mérida)" (Leith, 1938, p. 338).

Additional Material. From the same locality near the Caparo River, State of Barinas (=Zamora), collected by G. R. Pierce in 1951-1952. The fossils are contained in a soft, grey-white, iron-stained, micaceous siltstone, and preserved with some distortion as moulds.

Age. Middle Ordovician (Leith, 1938). Later collections have not included additional species that might throw further light on the precise horizon.

Description. The holotype shows the mould of the inner surface of the upper lamella of the fringe, but the new material includes moulds of the inner and outer surfaces of both lamellae of the fringe, as well as moulds of the pygidium and thorax, and enables amplification of Leith's description (1938, pp. 341-342, fig. 2).

Glabella clavate, expanding forward; occipital ring narrow, convex, long median spine, the shallow occipital furrow with deep appendiferal pits laterally. Immediately in front of the occipital furrow the glabella appears to be exceptionally inflated where it is crossed by the occiput (Pl. 1, figs. 2, 5), and in front of the occiput glabellar furrows may have been present, as in typical cryptolithinids. The distortion and crushing of the specimens (Pl. 1, figs. 1-3, 5) gives, however, a variable appearance to this portion of the glabella. Axial furrows with anterior pits. Cheek lobes descend steeply to fringe; cheek frame straight and transversely directed, fringe frame directed backward and outward so that posterolateral part of fringe is wide and projects posteriorly.

Fringe with outer surface of upper lamella sloping forward anteriorly, but anterolaterally and laterally convex, so that there is a depressed region adjacent to the cheek-lobe. Lower lamella slopes outward, anteriorly flexed at girder. Long genal spine directed backward and slightly outward. Girder a broad ridge anteriorly, less conspicuous anterolaterally and laterally, where a lower ridge (in the outer surface of the lower lamella) of almost equal width runs between the two rows of pits (I_1 and I_2) immediately inside the girder, and a narrower, still lower ridge separates the next inmost rows (I_2 and I_3; Pl. 1, fig. 2).

Near the genal angle these inner ridges die out, and the girder runs into the channel in the under-side of the genal spine (Pl. 1, fig. 4). Pits of E_2 smaller than those of E_1, laterally and anterolaterally in a continuous row, but anteriorly becoming irregular, and about 10 pits from the midline E_2 bifurcates and E_3 is formed in this anterior region (Pl. 1, fig. 1). The pits of E_3 are smaller and more numerous than those in E_2, and are not radially arranged with them. E_1 and I_1 are the largest pits in the fringe, in regular rows disturbed only at the genal angle, and anteriorly and laterally radially arranged with each other and the rows inside. I_2 complete in front of the glabella, I_3 commencing at about the 4th pit of I_2 from the median line, I_4 commencing anterolaterally, and additional rows laterally. In the inner, posterior part of the fringe concentric arrangement is replaced by quincuncial, while radial arrangement is conspicuous laterally and anterolaterally, especially in the depressed inner region. Low concentric ridges separate the pits of E_2 and E_1, E_1 and I_1, I_1 and I_2, especially laterally and anterolaterally. In this same region radial ridges separate the pits of E_1 and the rows inside it, and such ridges separate the pits of the internal region anteriorly. Numbers of pits in left side of fringe in holotype and original of Plate 1, figure 1, are respectively: E_2, 37 and 32; E_1, 31 and 29; I_1, 30 and 29; I_2, 32 and 30. No ornament is preserved on the moulds of the cheek lobes or glabella.

Four segments of the characteristic thorax poorly preserved as external mould (Pl. 1, fig. 6). Pygidium (Pl. 1, figs. 6, 7) subtriangular in outline, low axis reaching to tip, pleural regions flattened, with narrow, ridge-like border and steeply-descending margins. First axial ring and pleural furrow distinct, remainder of axis not subdivided, but two or three additional pleural furrows and interpleural ridges may be discerned running straight outward and backward.

Discussion. This species is clearly a cryptolithinid (Whittington, 1941, pp. 23-25) but is distinguished from *Cryptolithus* by the following: (a) There are two complete rows of pits outside the girder, and a third row anteriorly. (b) Characteristic radial ridges do not separate the pits in the outer row.

The pits of E_2 are smaller than those of E_1, especially later-

ally, and here the upper lamella is convex upward, with a depressed region adjacent to the cheek lobe. These same characters distinguish the Venezuelan species from species of *Cryptolithoides* (Whittington, 1941), and in addition the cephalon of *Cryptolithoides* has a different outline, and the pits inside the outer two rows are irregularly arranged laterally. While the Venezuelan material shows some features suggestive of *Broeggerolithus* (see Whittington, 1941, p. 24; Bancroft, 1949, pp. 298-299, Pl. 9, figs. 4, 5, 6, 8, Pl. 11, fig. 38), but has more rows of pits in the fringe and lacks the strong radial ridges in E_1, it is much more like species of *Onnia* (Whittington, 1940, Pl. 3; Lamont, 1948, Pl. 1; Bancroft, 1949, p. 299, Pl. 9, figs. 9-13, Pl. 10, fig. 16). These latter have E_2 of small pits, E_1 and I_1 of larger pits, and the region within I_1 showing a strong radial arrangement, particularly in the depressed lateral region. The girder in *Onnia* is strong anteriorly, but laterally concentric ridges of almost equal strength may run between E_1 and E_2, and/or I_1 and I_2 (e.g. Whittington, 1940, Pl. 3, fig. 5; Lamont, 1948, Pl. 1, figs. 4, 5). *O. terryi* shows a comparable development of ridges in the outer surface of the lower lamella in the interior region (Pl. 1, figs. 2, 4). *O. terryi* differs from other species of *Onnia* in the presence of E_3 anteriorly, but this single feature scarcely seems to warrant the erection of a separate genus. The development of additional external rows of pits anteriorly occurs in the probably older genus *Salterolithus* (Bancroft, 1949, p. 292, Pl. 9, figs. 1, 2), but species of this genus have fewer rows of pits internal to the girder.

Onnia is known from Middle and Upper Ordovician rocks in central and northern Britain, Bohemia, and as far south as North Africa (Termier and Termier, 1950, Pl. 187, figs. 8-11). The occurrence of *Onnia* in Venezuela suggests the possibility of a faunal province extending from central Europe and North Africa to northern South America in Ordovician times. Such a province may have passed through what is now Florida, for *Colpocoryphe exsul* Whittington, 1953, from early Middle Ordovician rocks of Florida, also has central European-North African affinity. If such a province existed, it is notable that it appears to lie almost entirely east and south of the belt of Upper Cambrian and early Ordovician "Atlantic faunas" recently portrayed by Wilson (1954, fig. 4), and that the rocks are mainly clastic.

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EXPLANATION OF PLATE

Onnia terryi (Leith, 1938). Caparo-Bellavista Series, Middle Ordovician, near the Caparo River, State of Barinas, Venezuela.

Fig. 1. Rubber cast from external mould of cephalon, showing upper lamella of fringe, X 4, MCZ 5183a. Extremities of third external row of pits indicated by "E_3."

Fig. 2. Mould of internal surface of glabella and cheek lobes, external surface of lower lamella of fringe, X 3, MCZ 5183b. Position of first (E_1) and second (E_2) external row of pits, girder (g), and of first (I_1), second (I_2), and third (I_3), internal rows shown.

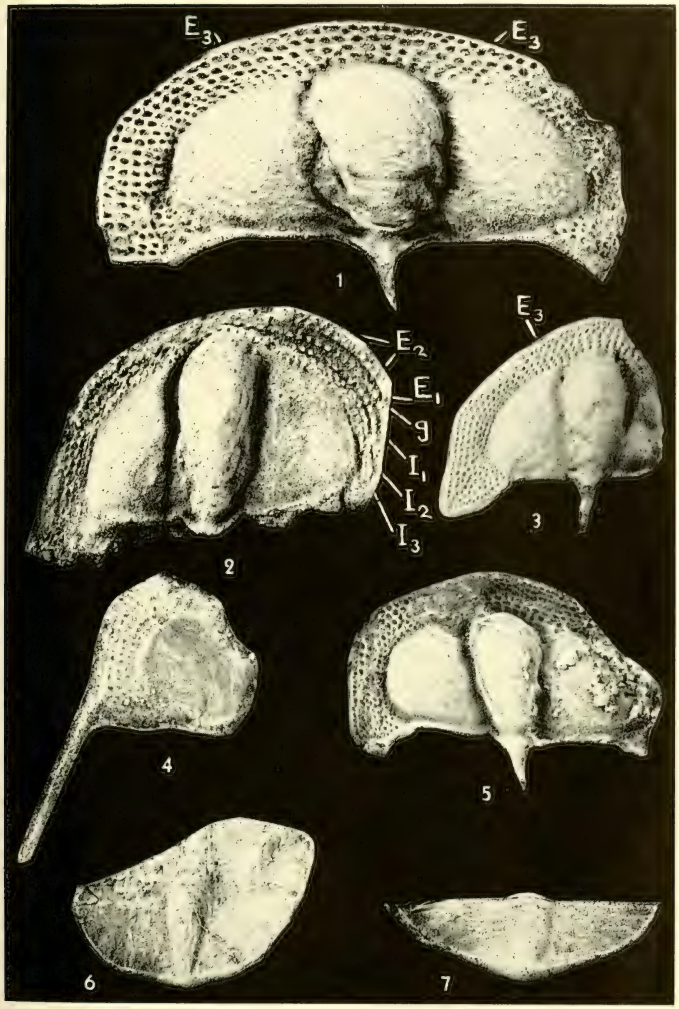
Fig. 3. Holotype, original of Leith (1938, fig. 2), internal mould of glabella, cheek lobes and inner surface of upper lamella of fringe, X 2, Peabody Museum, Yale University, 15317. Extremity of third external row indicated by "E_3."

Fig. 4. Mould of external surface of right cheek lobe, lower lamella of fringe and genal spine, X 3, MCZ 5183c.

Fig. 5. Internal mould of cephalon showing upper lamella of fringe, X 2½, MCZ 5183d.

Fig. 6. Rubber cast from external mould of pygidium and four poorly preserved thoracic segments, X 3, MCZ 5183e.

Fig. 7. Rubber cast from external mould of pygidium, X3, MCZ 5183f.


E3
E3
1
E3
E2
E1
9
I1
I2
I3
2
3
4
5
6
7

BREVIORA

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NEW OR REDESCRIBED PELOMEDUSID SKULLS FROM THE TERTIARY OF AFRICA AND ASIA (TESTUDINES, PELOMEDUSIDAE)

2. A Podocnemide Skull from the Miocene of Moghara, Egypt.

BY ERNEST WILLIAMS

In 1952-1953 while visiting the British Museum (Natural History) as a Guggenheim Fellow I was privileged to examine an undescribed skull from the Moghara Miocene of Egypt. The skull evidently belonged to a member of the genus *Podocnemis sensu lato* or to a close relative of that genus; the critical recognition marks of this section of the Pelomedusidae — the enlarged "carotid" channel, and the contact of basioccipital and quadrate — were readily visible. Further examination left no doubt of the novelty of this fossil as compared with any previously known podocnemide [1] skull, and suggested interesting problems in regard to its proper correlation with a shell name and in regard to its phyletic position.

The British Museum Moghara skull is unfortunately imperfect in many respects. The snout is missing so that important characters and relations here cannot be checked. Major parts of the postorbitals and jugals are broken away, as are both squamosals, the quadrate of one side, parts of the parietals and the occipital condyle.

Many structural details of taxonomic and phyletic importance are therefore not ascertainable: the presence or absence of a complete temporal roof, the presence or absence of a vomer, the position of the foramina incisiva, the relations of the internal laminae of the premaxillae and maxillae to each other and to

[1] I use the term "podocnemide" as a convenient and *informal* designation for a subsection of the family Pelomedusidae typified by the genus *Podocnemis*.

the choanal margin, the presence or absence of an anterior process of the palatines dividing the choanal opening, the presence or absence of a median pit in the palatal surface of the premaxillae and of a hooked process anteriorly on the premaxillae.

The following points may, however, be made out: The skull must have been rather broad, certainly very little longer than broad. The interparietal scale marked off by grooves on the skull roof is broad also, but tapers posteriorly, so that the parietal scales must have met behind it. There is no hint of a forehead groove but perhaps too little of the interorbital region is preserved. The orbits are visible in dorsal view.

There were two triturating ridges on the posterior portion of the palatal surface of the maxilla — a low, rough, median ridge and, parallel to it, a still lower, rougher, ridge at the margin of the choanae. There was no extreme development of a secondary palate.

Grooves on the postorbital bar indicate the presence of a "subocular" scute in the sense of Siebenrock (1902).

The "carotid" channel is fully enlarged in podocnemide fashion.

The ectopterygoid processes are large, blunt and almost wholly lateral in orientation. The basisphenoid is a conspicuous triangular element, the anterior apex blunted. There is a narrow basioccipital quadrate contact, more longitudinal than transverse.

The cavum tympani is large and lacks a precolumellar fossa.

These determinable characters are few indeed on which to hazard an estimate of the relationships of the Moghara form. One method of appraisal, however, is to tabulate the more diagnostic of these characters against the characters of other known podocnemide skulls. Tabulating first against the living podocnemide species (Table 1), we find that very little is learned except that the British Museum Moghara skull is not exactly like that of any modern podocnemide. If, now, we compare the British Museum Moghara skull with the previously known fossil skulls of podocnemide type (Table 2), the impressive fact is the close agreement, in cited characters, of the British Museum skull and *Dacquemys palcomorpha*. We need in fact to inquire what characters assure us that we are not dealing with *Dacquemys*.

TABLE 1

Moghara skull	*Vejdis regii lemmus*	*Podocnemis sensu stricto* *capensis*	*scutbereniata*	*Erymnochelys madagascariensis*	*Peltocephalus dumerilianus*
a broad skull	no	yes	yes	yes	no
parietal scales meeting behind interparietal	yes	usually yes	no	yes	no
forehead groove absent	no	no	no	yes	yes
orbits visible from above	yes	yes	yes	yes	no
two parallel ridges on maxilla	yes	no	no	no	no
extreme secondary palate absent	yes	yes	yes	yes	yes
subocular scales present	yes	usually no	yes	yes or no	no
narrow basioccipital-quadrate contact	yes	no	yes	yes	yes
precolumellar fossa absent	no	yes	yes	no	no

TABLE 2

Moghara skull	*Stereogenys cromeri*	*Shweboemys pilgrimi*	*Bacquemys pateomorpha*
a broad skull	yes	yes	no
parietal scales meeting behind interparietal	?	?	yes
forehead groove absent	yes	yes	yes
orbits visible from above	yes	yes	no
two parallel ridges on maxilla	no	no	yes
extreme secondary palate absent	no	no	yes
suboccular scales present	no	no	yes
narrow lasioccipital-quadrate contact	?	?	yes
precolumellar fossa absent	yes	yes	yes

It is unfortunate that the unique generic character of *Dacquemys* — the long squamosal-parietal suture — cannot be verified or denied for the Moghara specimen. This region has been broken away.

There are, however, differences which may or may not imply generic distinctness. The British Museum skull is broad; that of *Dacquemys* is elongate. The orbits are visible dorsally in the Miocene specimen; they are completely concealed in Oligocene *Dacquemys*. The two triturating ridges are low and rough in the Moghara specimen, the inner parachoanal ridge especially so; the same ridges are high, smooth and sharply defined in *Dacquemys*.

The suggestive point about these differences is the fact that in each case the Moghara skull is closer in these characters to *Erymnochelys* (=*Podocnemis madagascarensis* of Boulenger) than to *Dacquemys*. The skull of *Erymnochelys madagascarensis* is relatively broad, the orbits are exposed dorsally, there is but one low ridge on the triturating surface of the maxilla. But in regard to the last character there is some roughening of the parachoanal border of the maxilla in *Erymnochelys;* the condition in that genus could be explained as a further carrying through of a trend initiated in the British Museum skull. In fact the British Museum skull might on all its characters be interpreted as an intermediate between *Dacquemys* and *Erymnochelys*, perhaps somewhat closer to *Erymnochelys*.

If we assume the reality of this intermediate phyletic station of the British Museum Moghara skull, it is then probable that this skull belongs with the common podocnemide shell of the Moghara deposit, the shell type named by Andrews *Podocnemis aegyptiaca*, which has every shell character of *Erymnochelys* and is on shell characters barely, if at all, distinguishable from *Erymnochelys madagascarensis*. I shall hereafter refer to *Podocnemis aegyptiaca* Andrews as *Erymnochelys aegyptiaca* (Andrews).

There is only one other podocnemide shell type known from Moghara — the form named by Fourtau (1920) "*Podocnemis*" *bramlyi*. This form differs from *Erymnochelys aegyptiaca* and from all *Erymnochelys* in the larger size of the intergular scale which separates the gulars as in the Recent South American

podocnemide species (*Podocnemis sensu stricto* and most specimens of *Peltocephalus*). If we could assume that *P. bramlyi* is a precursor of *Peltocephalus* then it would not be too anomalous for our Moghara skull to belong to this species, rather than to *E. aegyptiaca*. In the living species *Peltocephalus dumeriliana* (in which the gular-intergular pattern is typically very similar to that of *P. bramlyi*) the skull has definite, strong similarity to that of *Erymnochelys* or of *Dacquemys* and thus also to the Moghara skull.

I know of no grounds for decision between the two alternatives thus presented. The British Museum skull may as plausibly belong to *P. bramlyi* as to *E. aegyptiaca*. We have too little of the Moghara skull, and in addition we are probably too close to the branching off point of *Peltocephalus* and *Erymnochelys* to expect wide differences in skull structure between these two, then nascent, genera. But, though we must thus remain undecided as to the species allocation of the Moghara skull, I think that one positive statement of some importance may be made. The Moghara skull — on whichever fork of the phyletic tree it belongs — is a structural intermediate between the Recent genera, *Peltocephalus* or *Erymnochelys*, and the Oligocene *Dacquemys*.

This, indeed, is the principal suggestion that I wish to make: that there is a phyletic relationship between *Peltocephalus*, *Erymnochelys* and *Dacquemys* of the sort diagrammed below (Fig. 1).

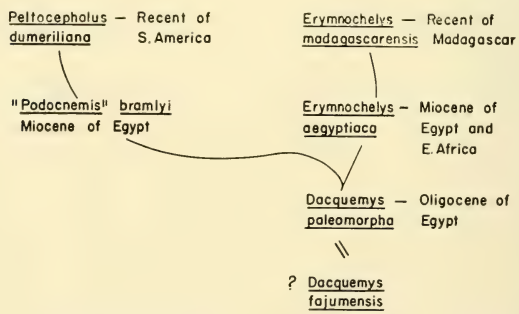

Fig. 1 Presumed phyletic position of the Egyptian Miocene podocnemides

It cannot be denied that this suggested phylogeny rests upon a rather elaborate structure of inferences, any or all of which may be wrong; nothing else, however, is possible in the current state of the evidence.

It may be useful, here, to compare this suggestion with the previous phyletic scheme for "*Podocnemis*" which was set up by Dacqué and has been accepted by Zangerl. The points of agreement will be found to be more numerous than at first seems the case. We are agreed that there are two lines within the pelomedusid species grouped as *Podocnemis* by Boulenger, Andrews and others — an African and a South American line. I differ with Dacqué, Zangerl and others in that I separate from the South American group the species *dumeriliana* (type of *Peltocephalus*) and regard the few resemblances of the latter species to the other South American forms — similarity in gular pattern and in cervical articulations — as convergent only. I further postulate a considerable evolution in skull structure within the line which we may still, for convenience, call African — an evolution involving so much morphological divergence that I recognize three genera within this lineage.

Of these two respects in which I differ with the Dacqué-Zangerl phylogeny, the recognition of African affinities in *Peltocephalus dumerilianа* is the more solidly founded. I shall argue this point at length in a future discussion of the rank, characters and variation of the living species placed by Boulenger in *Podocnemis*. The second conception — that of the *Dacquemys-Erymnochelys-Peltocephalus* series — is as yet hypothesis only, and the grounds for this view have been stated here.

It needs to be mentioned that Dacqué (1912) described another skull from Moghara which he named *Sternothaerus blanckenhorni*. The description is very brief and the only figure is a dorsal view. The skull was also quite imperfect, lacking the temporal and occipital regions.

If it belongs to *Sternothaerus* (=*Pelusios*) — an assignment neither contradicted nor specially supported by the figure — it has, of course, nothing to do with the skull which has here been described. However, in dorsal view there would be few differences in such imperfect fragments as these two skulls from Moghara; I think, nevertheless, that the interorbital width is greater in the skull which has been here discussed than in the

type of *blanckenhorni*. Beyond this, we must rely on Dacqué's description of differences, and his most significant remark appears to be his observation: "Bemerkenswert erscheint, dasz die Maxillaria die Choane auf der Schädelunterseite offenbar ganz überdecken." This remark would appear to imply a strongly developed secondary palate, a striking difference from the skull here noticed; maxillary ridges are also unmentioned. It must be commented that a strong secondary palate would be remarkable also in the genus *Pelusios* and resembles more closely conditions in the *Stereogenys-Shweboemys* series (which will be discussed in the concluding paper of this series), but in any event "*Sternothaerus*" *blanckenhorni* would appear to have no bearing on the problems raised by the skull in the British Museum.

I am indebted to Dr. W. E. Swinton for the privilege of examining and describing the British Museum skull from Moghara. The photographs of this specimen are published with the permission of the Trustees of the British Museum; they were made by Peter Green of the British Museum staff.

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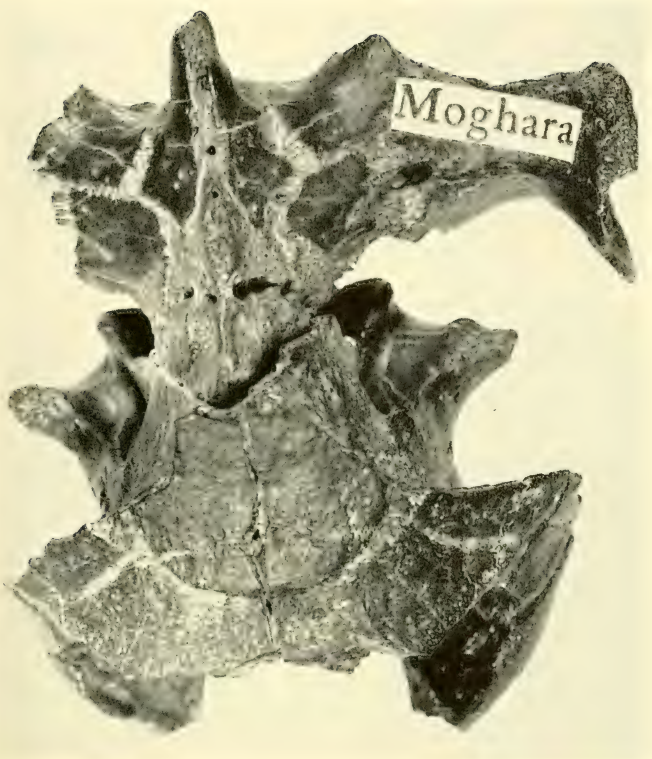

PLATE 1.

British Museum skull from Moghara, dorsal view. Posterior end at top of page.

PLATE 2.

British Museum skull from Moghara, ventral view. Posterior end at top of page.

B R E V I O R A

Museum of Comparative Zoology

Cambridge, Mass. November 29, 1954 Number 40

SOME MOLLUSKS FROM THE CONTINENTAL SLOPE OF NORTHEASTERN NORTH AMERICA[1]

By Arthur H. Clarke, Jr.

The continental slope area of northeastern North America has always been a relatively unknown and unexplored region. Only meager information has been on record in regard to the kind and abundance of its fauna. More knowledge is desirable, not only for academic interest, but also that proper evaluation may be made with the ultimate aim of supplementing man's ever-increasing need for additional sources of food.

With these objects in mind, in 1952 and 1953 the Woods Hole Oceanographic Institution began a survey of the bottom fauna existing on the continental slope area. An eighty-three foot trawler, the *Cap'n Bill II* was equipped for the task, and bottom trawlings were made along the slope from a point east of Cape Charles, Virginia, to a point southeast of Nova Scotia in various depths ranging approximately from 100 to 700 fathoms. Otter trawls were used carrying one and one-half inch mesh at the cod end, and measuring thirty-five feet, fifty feet, and sixty-five feet initially across the mouth. The work was under the direction of Mr. W. C. Schroeder of the Woods Hole Oceanographic Institution, to whom we are indebted for the fine array of mollusks collected.

Mollusks were not the primary concern of the survey, and the large size of the mesh prevented retention of the smaller specimens, though many of the larger species were obtained. These were submitted to Dr. W. J. Clench, Curator of Mollusks at the Museum of Comparative Zoology to be added to the research collection.

[1] Contribution No. 722 from the Woods Hole Oceanographic Institution.

After identification of the mollusks collected, a search of the literature was made so that the data gained from this survey could be compared with previous records. Two papers by A. E. Verrill (1884 and 1885) were found listing the bathymetric ranges of all of the then known western Atlantic species of marine mollusks found below 60 fathoms.

Verrill's records have apparently been generally overlooked by many of the more recent compilers of molluscan lists. His data, as obtained primarily from material gathered by the U.S. Fish Commission steamers *Fish Hawk* and *Albatross* from 1880 to 1884, indicate much more extensive bathymetric ranges for a great many species than have subsequently been given. W. H. Dall, in his "Preliminary Catalog . . ." (1889) omitted much of Verrill's data, and although Dall frankly stated that his catalog was incomplete, this oversight has been perpetuated by later writers. It is urged that future investigators refer to Verrill's most complete and excellent list as a supplement to modern lists.

In the following tabulation of species collected by the *Cap'n Bill II*, the minimum depth range indicated by the data is given. For instance, if a particular species was found at two stations where the depths of trawling ranged from 200 to 250 fathoms and from 300 to 350 fathoms respectively, the minimum range would be 250 to 300 fathoms. A distinction is also made between living and dead specimens, and bathymetric ranges are given for each, if not identical. For comparative purposes, the broadest bathymetric and geographic ranges indicated by the literature are also included, and information sources are cited. When geographic ranges are extended, these localities are defined in terms of miles from a position on land. When not extended, approximate location only is indicated.

By examination of the following list of 28 species, it will be seen that these new data have extended the previously recorded bathymetric ranges of seven species (marked *) and the geographic ranges of six species (marked †).

List of Mollusca Collected

Yoldia thraciaeformis (Storer)*†

One large dead specimen at station 72. *Bathymetric range*: 400 fms. dead (this survey); 29-182 fms. dead (Verrill 1884).

Geographic range: 240 mi. east of Sandy Hook, New Jersey (this survey); Gulf of St. Lawrence to Massachusetts (Johnson 1934); West Greenland (Thorson 1951).

Pecten vitreus (Gmelin)

Three living and two dead specimens at station 110. Three living specimens at station 208. *Bathymetric range*: 250-320 fms. (this survey); 50-800 fms. (Dall 1889). *Geographic range*: Arctic Ocean (Dall 1889); off Newfoundland and Nova Scotia (Johnson 1934); south of Nova Scotia (this survey); off Martha's Vineyard (Johnson 1934); east of Sandy Hook, New Jersey (this survey); west Florida [Gulf of Mexico] (Dall 1889); Europe; Mediterranean Sea; Africa (all Verrill 1884); west Greenland (Thorson 1951).

Anomia aculeata Müller

Living specimens attached to shells and rocks at stations 14, 19, 38, 53, 110, 131, 173, and 195. *Bathymetric range*: 145-320 fms. (this survey); 4-640 fms. (Verrill 1884); 0-80 fms. (Dall 1889). *Geographic range*: Arctic Ocean to Cape Hatteras, North Carolina (Dall 1889); south of Nova Scotia to east of Cape Henlopen, Delaware (this survey); Europe (Dall 1889).

A very variable species. The normal imbricated or scaly surface sculpture is entirely lacking in many individuals and in some entire large lots of specimens.

Arctica islandica (Linné)

Three single valves at station 1. *Bathymetric range*: 33 fms. dead (this survey); 6-90 fms. (Johnson 1934). *Geographic range*: east of Montauk Point, Long Island, New York (this survey); Arctic Ocean to Cape Hatteras, North Carolina (Dall 1889).

Astarte subaequilatera Sowerby

Three small living specimens at station 86. *Bathymetric range*: 230 fms. (this survey); 22-410 fms. (Johnson 1934). *Geographic range*: Labrador to Florida (Johnson 1934); south of Nova Scotia (this survey).

Panomya arctica (Lamarck)†

One very large, apparently freshly dead specimen at station 38. *Bathymetric range*: 190 fms. dead (this survey); 20-506 fms.

dead: 300 fms. alive (both, Verrill 1884). *Geographic range*: Arctic Ocean to Georges Bank; circumpolar (both, Johnson 1934); 170 mi. east of Barnegat Bay, New Jersey (this survey).

The specimen cited measures as follows: length 109 mm., height 74 mm., width (valves together) 48 mm. A similar specimen, alive and nearly as large, was taken nearby by the *Caryn* in 1949 (39°57′N., 70°38′W.), thereby confirming the fact that the species exists alive in this area.

Calliostoma bairdi Verrill and Smith

One dead specimen at station 83. One living specimen at station 146. *Bathymetric range*: 87 fms. dead; 65 fms. alive (both this survey); 56-640 fms. dead; 64-192 fms. alive (both, Verrill 1884). *Geographic range*: south southeast of Nantucket (270 mi. east of Barnegat Bay, New Jersey); east of Cape Henlopen, New Jersey (both, this survey); south of Martha's Vineyard to Florida Keys (Johnson 1934); Caribbean Sea (Verrill 1889).

The living specimen is very beautiful. Patches of lavender are seen through the thin iridescent periostracum which appears golden between the spiral rows of tubercules on the upper whorls and golden peach on the lower whorls. The inner nacre of the aperture shines with iridescent pink and green. The circular operculum is multispiral, typical of the family.

Solariella ottoi (Philippi)

One dead specimen at station 72. Three living specimens at station 211. *Bathymetric range*: 400 fms. dead; 600 fms. alive (both, this survey); 64-1555 fms. (Dall 1889). *Geographic range*: south of Martha's Vineyard and Georges Bank (Johnson 1934); east of Sandy Hook, New Jersey (this survey); New Jersey; Virginia (both, Dall 1889); Florida Keys; West Indies (both, Johnson 1934); St. Thomas, Virgin Islands (Dall 1889).

Natica clausa Broderip and Sowerby

One very large dead specimen (23 mm. long) at station 182. *Bathymetric range*: 280 fms. dead (this survey); 13-1255 fms. dead; 238-843 fms. alive (both, Verrill 1884); 16-1537 fms. (Johnson 1934). *Geographic range*: Arctic [Ocean] (Verrill 1884); Labrador to off North Carolina (Johnson 1934); south-

east of Cape Sable, Nova Scotia (this survey); Europe (Verrill 1884); Arctic and Bering seas to San Diego, California; Japan (both, La Rocque 1953).

Polinices heros (Say)

One dead specimen at station 144. *Bathymetric range*: 150 fms. dead (this survey); 0-238 fms. (Dall 1889). *Geographic range*: Gulf of St. Lawrence to North Carolina (Johnson 1934); east of Chincoteague Island, Virginia (this survey).

Polinices triseriata (Say)*

One very large, dead specimen (33 mm. long) at station 144. One dead specimen at station 200. *Bathymetric range*: 100-150 fms. dead (this survey); 0-63 fms. (Dall 1889). *Geographic range*: Labrador to Cape Hatteras (Dall 1889); south of Georges Bank to east of Chincoteague Island, Virginia (this survey).

Capulus ungaricus (Linné)

One small living specimen attached to *Pecten vitreus* at station 110. *Bathymetric range*: 320 fms. alive (this survey); 1-458 fms. (Johnson 1934). *Geographic range*: south southeast of Cape Sable, Nova Scotia (this survey); Greenland to Florida (Johnson 1934); Europe (La Rocque 1953).

Aporrhais occidentalis (Beck)*

Living specimens at stations 95 and 177. Dead specimens at stations 38, 83, 86, 95, 164, 176, 182, and 184. *Bathymetric range*: 340-360 fms. alive, 90-365 fms. dead (both, this survey); 115-349 fms. alive; 34½-1000 fms. dead (both, Verrill 1884). *Geographic range*: Gulf of St. Lawrence to off North Carolina (Johnson 1934); southeast of Nova Scotia to south of Nantucket (this survey); west Greenland (Thorson 1951).

Buccinum ciliatum Bruguière

One small living specimen at station 184 (southeast of Cape Sable, Nova Scotia). *Bathymetric range*: 265 fms. alive (this survey); 26-471 fms. (Johnson 1934). *Geographic range*: Arctic [Ocean] (Verrill 1884); Labrador to Cape Cod, Massachusetts (Johnson 1934); southeast of Cape Sable, Nova Scotia (this survey); Europe (Verrill 1884).

Neptunea decemcostata (Say)*†

Living specimens at stations 88, 95, 110, 165, 173, 182, and 184. Dead specimens at stations 38, 72, 86, 104, 164, 187, and 195. *Bathymetric range*: 270-360 fms. alive; 225-660 fms. dead (both this survey); 41-86 fms. alive; 6-322 fms. dead (both, Verrill 1884). *Geographic range*: Circumboreal (La Roeque 1953); Nova Scotia to Massachusetts Bay and Georges Bank (Johnson 1934); southeast of Nova Scotia to 240 mi. east of Barnegat Bay, New Jersey (south of Nantucket) (this survey).

Great variation of form exists in this species. Some specimens are attenuated to the extent that the length is 2½ times the greatest width. Other specimens show a length of only 1½ times the width. Variation is also seen in degree of sculpture, length of aperture in relation to overall length, etc. The possibility of the existence of one or more clines will be investigated.

Neptunea despecta tornata (Gould)*†

One small, dead specimen at station 159. *Bathymetric range*: 690 fms. dead (this survey); 10-471 fms. (Johnson 1934). *Geographic range*: Gulf of St. Lawrence to off Martha's Vineyard (Johnson 1934); 120 mi. east of Atlantic City, New Jersey (this survey).

Colus islandicus (Gmelin)

Dead specimens at stations 5, 22, 23, 29, 84, 144, 201, and 225. *Bathymetric range*: 85-415 fms. dead (this survey); 20-1650 fms. (Dall 1889). *Geographic range*: Labrador to Norway (Johnson 1934); Arctic Sea to South Carolina (Dall 1889), south of Georges Bank to east of Chincoteague Island, Virginia (this survey).

Colus stimpsoni stimpsoni (Mörch)

Two living specimens at station 152. One dead specimen at station 201. *Bathymetric range*: 330 fms. alive; 85-87 fms. dead (both, this survey); 1-471 fms. (Johnson 1934). *Geographic range*: Arctic Sea to [Cape] Hatteras, [North Carolina] (Dall 1889); south of Georges Bank to east of Cape Henlopen, New Jersey (this survey).

Colus pubescens (Verrill)*

Living specimens at stations 10, 13, 17, 53, 72, 139, 182, and

184. Dead specimens at stations 8, 10, 14, 17, 19, 35, 49, 83, 95, 104, 114, 131, 132, 139, 144, 164, 173, 184, and 225. *Bathymetric range*: 130-400 fms. alive; 90-415 fms. dead (both, this survey); 18-179 fms. dead; 192-640 fms. alive (both, Verrill 1884). *Geographic range*: Gulf of St. Lawrence to North Carolina (Johnson 1934); Nova Scotia to South Carolina (Dall 1889); southeast of Nova Scotia to east of Chincoteague Island, Virginia (this survey).

Pleurotomella agassizi Verrill and Smith†

One dead specimen at station 211. *Bathymetric range*: 600 fms. dead (this survey); 39-1309 fms. alive; 1608 fms. dead (both, Verrill 1884). *Geographic range*: 105 mi. southeast of Nantucket (this survey); south of Martha's Vineyard to the West Indies (Johnson 1934).

Scaphander punctostriatus (Mighels and Adams)

One living specimen at station 109 and one living specimen at station 189. *Bathymetric range*: 240-305 fms. alive (this survey); 46-1255 fms. alive; 1362-1467 fms. dead (both, Verrill 1884). *Geographic range*: Gulf of St. Lawrence to West Indies (Johnson 1934); southeast of Nova Scotia (this survey); Barbados; Norway (both, Dall 1889).

Rossia sublaevis Verrill

One living specimen at station 69. *Bathymetric range*: 490 fms. (this survey); 45-640 fms. (Johnson 1934). *Geographic range*: Newfoundland to 32°33′15″N. (Johnson 1934); south of Georges Bank (this survey).

Illex illecebrosa (Lesueur)

Two living specimens at station 68 and one living specimen at station 74. *Bathymetric range*: 450 fms. (this survey); 0-1022 fms.; beaks 1091-1917 fms. (both, Verrill 1884). *Geographic range*: south of Georges Bank (this survey); Greenland to Cape Hatteras (Johnson 1934).

Chiroteuthis lacertosa Verrill

One living specimen at each of the following stations: 68, 69, and 74. *Bathymetric range*: 490-500 fms. (this survey); 435-2369 fms. (Johnson 1934); arms, 2949 fms. (Verrill 1884).

Geographic range: south of Georges Bank (this survey); Nova Scotia to West Indies (Johnson 1934).

MASTIGOTEUTHIS AGASSIZII Verrill*

One living specimen at station 102. *Bathymetric range*: 600 fms. (this survey); 640-1050 fms. (Johnson 1934). *Geographic range*: Gulf of Maine to North Carolina (Johnson 1934); southeast of Nova Scotia (this survey).

ALLOPOSUS MOLLIS Verrill†

One living specimen at station 69 (south of Georges Bank) and one living specimen at station 90 (southeast of Nova Scotia). *Bathymetric range*: 330-490 fms. (this survey); 238-1346 fms.; fragment, 1735 fms. (both, Verrill 1884). *Geographic range*: 110 mi. southeast of Cape Sable, Nova Scotia; south of Georges Bank (both, this survey); Nantucket to Chesapeake Bay, eastern Atlantic (both, Johnson 1934).

BATHYPOLYPUS ARCTICUS (Prösch)

One living specimen at station 69 and one living specimen at station 72. *Bathymetric range*: 450-490 fms. (this survey); 28-843 fms. (Johnson 1934). *Geographic range*: south of Georges Bank (this survey); Bay of Fundy to 32°N. (Johnson 1934).

GRANELEDONE VERRUCOSA (Verrill)

One living specimen at station 69. *Bathymetric range*: 490 fms. (this survey); 466-1255 fms. (Johnson 1934). *Geographic range*: south of Georges Bank (this survey); Nova Scotia to Delaware Bay (Johnson 1934).

Location and Depth of Stations Cited

Station Number	North Latitude	West Longitude	Depth in Fathoms
1	40°50′	71°09′	33
5	39°35′	71°57′	240-260
8	39°36′	71°52′	405-410
10	39°46′	71°35′	395-405
13	39°55′	71°27′	180-190
14	39°56′	71°26′	150
17	39°55′	71°17′	290-330
19	39°57′	71°13′	175-180
22	39°53′	70°53′	300-330

23	39°52′	70°51′	375-420
29	39°52′	70°43′	415-440
35	40°02′	70°24′	105-110
38	40°04′	70°12′	190-225
49	39°57′	69°37′	415-560
53	39°55′	69°26′	165-180
68	40°08′	68°19′	400-510
69	40°10′	68°16′	490
72	40°12′	68°08′	400-450
74	40°17′	67°53′	450-500
83	39°59′	69°32′	87-90
84	39°59′	69°35′	82-85
86	42°23′	64°58′	230-245
88	42°46′	63°22′	340-350
90	42°41′	63°33′	300-330
95	42°45′	63°47′	330-340
102	42°35′	64°03′	560-600
104	42°40′	64°08′	350-380
109	42°20′	65°03′	305-320
110	42°17′	65°06′	320-360
114	40°46′	66°40′	290-300
131	38°13′	73°40′	145-160
132	38°08′	73°45′	205-275
139	37°38′	74°14′	120-130
144	37°45′	74°09′	150
146	38°33′	73°18′	63-65
152	38°39′	73°05′	330-400
159	39°26′	72°10′	690-720
164	42°43′	63°50′	310-335
165	42°42′	63°47′	360-370
173	42°40′	64°10′	240-270
176	42°33′	64°17′	280-320
177	42°32′	64°19′	360-420
182	42°28′	64°31′	280-305
184	42°23′	64°52′	265-295
187	42°15′	64°58′	660-705
189	42°18′	65°05′	220-240
195	40°34′	67°02′	290-300
200	40°46′	66°48′	100-105
201	40°45′	66°51′	85-87
208	40°09′	68°24′	250-340
211	40°00′	68°49′	600-670
225	39°53′	70°40′	345-355

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Map of continental slope area showing location of listed stations.

BREVIORA

Museum of Comparative Zoology

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COMMENTS ON THE CLASSIFICATION OF RODENTS

BY ALBERT E. WOOD

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There is no order of mammals where there are so many uncertainties in the current classification as there are in the rodents. The rodents have generally been subdivided into three groups, the Sciuromorpha, Myomorpha and Hystricomorpha, although there have been several attempts (notably Miller and Gidley, 1918, and Winge, 1924) to break away from the tripartite division. The morphologic criteria on which these three groups are based permits living rodents to be marshalled into them with greater or lesser success. But the resulting problems remain very prominent, and well-nigh insuperable when the paleontologic history of the order is taken into account. For example, if the Hystricomorpha are a natural group, how can their present distribution (South America, Africa, southern Europe and south Asia, with scattered recent Latin American immigrants to North America) be explained in view of the complete absence of Tertiary hystricomorphs in North America? Moreover, the morphology of the various genera and families of fossil rodents does not permit these forms to fit into a three-fold classification anywhere near as well as do the living members of the order.

As long as we deal only with the living members of the order, the criteria for subordinal classification can be sorted out fairly well. However, studies of fossil rodents have shown that sometimes the structures on which the classification has been based were independently derived by diverse groups. For example, Wood (1937) showed that the sciuromorph type of zygoma and masseter was developed in the Oligocene genus *Titanotheriomys*, a form that by no stretch of the imagination

could be considered to be ancestral to anything included among the recent sciuromorphs.

As a result of general dissatisfaction with the three-fold classification, there have been a number of attempts to arrive at alternative arrangements. Those of Miller and Gidley (1918) and Winge (1924) developed so many additional problems, while solving a few, that they are not generally followed at present.

Wood (1937) basically followed the three-fold arrangement, but proposed a fourth subdivision, the Protrogomorpha, to include the primitive rodents that have not acquired the features of the jaw muscles that characterize the members of the three classic suborders. All members of this suborder are extinct except for *Aplodontia*, the "Mountain Beaver" of parts of California, Oregon, Washington and British Columbia.

Simpson (1945) made a valiant attempt to squeeze all rodents into the three-fold classification, though pointing out in many places that the scheme does not work well.

In an extensive review of the early Tertiary rodents of North America, Wilson (1949) followed Simpson's classification but raised many queries and made a number of very significant suggestions, particularly as to the probability of a close relationship between the heteromyids and cricetids, heretofore generally considered to be sciuromorphs and myomorphs, respectively.

Simpson (1950) and Wood (1950) suggested that the South American "hystricomorphs" should perhaps be separated as a distinct suborder, though without working out the details. Wood (1955), and Wood and Patterson (in press) are formally carrying out such a separation, with detailed discussion as to the reasons for the change.

Lavocat (1951), in a review of certain Oligocene faunas of France, agreed with this point of view, and showed that the European Eocene and Oligocene Theridomyidae and Pseudosciuridae could not be ancestral to either the Old World or New World hystricomorphs of the present day.

For many years, Stehlin worked on a monograph of the evolution of rodent dentition, which was finished after his death by Schaub (Stehlin and Schaub, 1951). This deals exclusively with the dentition, and develops the thesis that rodents with five-crested teeth are all descended from animals with the basic tooth pattern represented by the European Eocene-Oligocene

theridomyids. Although this monograph contains a brief taxonomic section, there is no attempt to present a comprehensive revision of the classification of the order. There are, however, a large number of suggestions and comments which, while not building up any particular classification, must nevertheless be given serious consideration by anyone interested in the supergeneric arrangement of the rodents. I cannot agree with all of Schaub's conclusions, and am therefore attempting to explain some of these differences in detail here. The taxonomic results of these differences of opinion are being published elsewhere as a suggested classification of the rodents (Wood, 1955).

Schaub has recently (1953a) published a revised classification of the "Hystricomorph" rodents. In this paper and others (1951, 1953b; Stehlin and Schaub, 1951), he also makes comments on the "Sciuromorpha" and "Myomorpha". Basically, his idea is that these last two groups are wastebaskets, made up of superfamilies that have had an entirely independent history, and which cannot profitably be grouped in suborders. Although he is not explicit, he gives the impression that he feels that, in one or two cases, there might be some profit in grouping two of the superfamilies into a suborder. With this part of his thesis I feel a great deal of sympathy if not complete agreement, although the classification proposed in Wood, 1955, does not completely follow Schaub in doing away with these suborders. The rodents representing the initial North American Eocene radiation (the Ischyromyoidea), the middle Tertiary to Recent Aplodontoidea, and the Sciuridae certainly seem fairly closely related. At least they all retain primitive features of teeth, of the zygomasseteric region, or of both, and they may well be kept in a common suborder, for which the name Sciuromorpha may be retained. The other superfamilies usually called sciuromorphs seem to be quite distinct from these forms, and may belong in rather diverse parts of the order.

The families that Wood places in the Myomorpha, however, are a group about whose relationships there is little or no certainty. There are some suggestions of mutual relationship, and some indications that Schaub is correct in thinking that they have nothing in common with each other. If they are not related, this would be the end of the Myomorpha, and the superfamilies would have to be either left out of all suborders or, since this is

illegal in formal taxonomy, each placed in its own suborder.

It is therefore obvious that Schaub is correct in his contention that the classical concepts of the Sciuromorpha and Myomorpha will have to be abandoned, and either new and perhaps more restricted definitions developed for these suborders, or the subordinal concept will have to be largely abandoned for this order. It is still too early to reach a definite choice between these alternatives.

But on one of Schaub's major points I find myself in disagreement. One of the basic tenets of Stehlin and Schaub's invaluable monograph is that the Theridomyidae are ancestral to all forms that have a five-crested tooth pattern or that are derived from a five-crested ancestor. Schaub has therefore proposed a suborder, Pentalophodonta, to include all forms with five-crested teeth, or that are derivable from a five-crested ancestry. However, it seems no more reasonable to assume that a given tooth pattern has not arisen independently several times than to assume that a given zygomasseteric pattern has not so arisen. Indeed, all the current indications from the study of rodent evolution are that extensive parallelism is the rule rather than the exception in this order. Of Schaub's Pentalophodonta, the South American forms are surely a natural group, the Suborder Caviomorpha of Wood (1955), and the Infraorder Nototrogomorpha of Schaub (1953a). But these forms must have been derived from rodents that entered South America from North America, as is now generally agreed (Schaub, 1953a; Simpson, 1950; Wood, 1950). There is also agreement that this entry must have been no later than late Eocene. Schaub (1953a, p. 393) argues that this ancestral stock could have been theridomyids that crossed North America to reach South America in the Eocene, Paleocene, or even earlier.

It is impossible to prove that a form did not live in an area or at a time where it is not represented by fossils. But no rodents of any kind are known from South America before the Lower Oligocene Deseadan, at which time they have become quite abundant and are beginning to be diversified, although clearly stemming from a common origin. Because of the rapid diversification of the caviomorph rodents beginning with the Deseadan, it seems almost certain that, in this deposit, we are observing an explosive radiation in the process of exploding. A backward

extrapolation of the post-Deseadan rate of evolution would indicate that this explosion must have begun not very long prior to the deposition of the Deseado beds. Although such an extrapolation is dangerous, and although we obviously cannot be certain of the reasons for such an evolutionary explosion, by far the most reasonable interpretation, in view of what is known of the general Tertiary history of South America, is that the explosion began with the arrival of rodents in South America. Here was a virgin field, with no highly developed competition, and, once the rodents were established, they rapidly took over all gnawing niches. If this explanation is not correct, it is exceedingly difficult to understand the rapid post-Deseadan development of the caviomorphs. Hence it seems very questionable that rodents could have been present in South America for any appreciable time before the Deseado. If this postulate is accepted, and if their North American origin be granted, most authors consider it more probable that the caviomorphs were derived from known North American types (such as the Paramyidae or Sciuravidae) than from the European Theridomyidae, still unreported from any of the richly fossiliferous North American deposits.

An additional objection to Schaub's suggestion of a Paleocene or even earlier passage of the theridomyids to South America is the complete absence of any rodents from the record prior to the latest Paleocene, when only the single genus *Paramys* is known. Presumably there must have been rodents prior to their earliest appearance in the record, and they may have been in existence for some time, although there is no valid criterion for fixing the length of time necessary to differentiate the rodents from their ancestors. This time may therefore be fixed as long (extending back into the Cretaceous) or short (reaching only the Middle Paleocene), depending on the individual student's opinion as to the probable rates of evolution involved and the significance of the morphologic differences between *Paramys* and whatever group is postulated as the ancestor. Moreover, all the earliest rodents, both in North America and in Europe, are referable to the Paramyidae, and to the most primitive stages of that family. The only non-paramyid lowermost Eocene genus known is the pseudosciurid *Adelomys*, which Wood, in his

monograph of the Paramyidae, will indicate was derived from the paramyids.

The absence of theridomyids from North America is, of course, negative evidence. It is possible that this family may have lived in eastern North America where there are no continental Eocene deposits. But there is no evidence that the family was so represented, and it seems highly probable that the rodents that reached South America went by way of what is now Mexico and Central America, and hence were probably derived from the western part of the continent.

Therefore, while admitting that all this is negative evidence, it seems most probable that a representative of one of the known North American Eocene groups reached South America late in the Eocene, to give rise to the South American radiation.

A further point of disagreement with Schaub is in the phylogenetic position of the Paramyidae. Wood (1946) referred to the specialization of the Paramyidae, which indicated that they could not have the fundamental ancestral position generally given them. With this point of view, Schaub is in complete agreement (1953b, p. 35), considering that the Sciuridae have the most primitive tooth pattern in the order. Wood's 1946 opinion was based on preliminary investigation of the paramyids, which includes many rather specialized genera. Further study of Lower Eocene forms, however, has caused a revision of this opinion, and I now feel that the Upper Paleocene and Lower Eocene paramyids are the most primitive known rodents, although it is certain that the earliest sciurids have made little or no advance over them in the structure of the cheekteeth. The data for this conclusion have not been published, but are included in a monograph on the Paramyidae, now nearing completion. Therefore, the North American Paramyidae could have been ancestral to the South American radiation, although the intermediate steps have not been traced in detail. If the paramyids were the ancestors, Schaub's Suborder Pentalophodonta immediately becomes a composite group, the two infraorders having nothing in common.

Schaub places the Theridomyoidea, Castoroidea and Hystricoidea in the Infraorder Palaeotrogomorpha. But Lavocat (1951) has presented evidence, derived from structures other

than the cheekteeth, that the theridomyoids cannot be related to the hystricoids, so that this infraorder would also seem to be composite. Schaub places a number of other groups in the Palaeotrogomorpha, particularly the Spalacidae and Rhizomyidae. This seems perhaps somewhat less likely than that they belong in the Myomorpha, if there is any such group. Certainly there is not enough known of the history of either family to justify placing them with confidence in any particular category.

Schaub's new proposals for classification of rodents are very useful and thought-provoking. The fact that there are disagreements with them is not surprising. The current status of rodent phylogeny and classification is such that anyone can point out inconsistencies in anybody else's classification. The rodents are a sufficiently large and complex group so that no one person can be familiar with the entire order. Progress will be made only if various students attack the problem, even though it will result in presenting solutions that others can show obviously to be incorrect. Wood's current (1955) classification has been proposed with this object in view, in the hope that there will be as many criticisms, both constructive and destructive, as possible, since this is the only way to progress.

Schaub has made one further suggestion that very probably will be incorporated in the ultimate classification of the order. This is the idea that many of the superfamilies are entirely separate from all others, presumably having an independent history since the Eocene. There very clearly was a sudden diversification of the rodents, at or near the end of the Eocene, which apparently resulted from a rather sudden change from gnawing based on the use of the temporal muscle to that based largely on the use of the masseter, with consequent enlargement and modification of the latter. The present evidence suggests, but does not prove, that this occurred a great many times independently. It is very probable that these lines all developed from different groups of Eocene rodents, and that, therefore, each of these lines will deserve separate taxonomic treatment. Generally speaking, such superfamilial lines could be grouped into suborders only artificially. Although the present evidence suggests the probability of such a bushy phylogeny (rather than a tree with half a dozen main branches), it is perhaps more conserva-

tive to struggle with an attempt to group rodents into suborders for a while longer, while keeping in mind the possibility (or probability) that a classification with entirely independent superfamilies will ultimately prove to be the only one that will fit in with the facts of rodent paleontology, as these gradually come to light. Certainly it will be some time before an adequate classification of the order is compiled.

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BREVIORA

Museum of Comparative Zoology

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A NEW SALAMANDER OF THE GENUS *PARVIMOLGE* FROM MEXICO

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In the Museum of Comparative Zoology there is a specimen of a Mexican plethodontid salamander superficially similar to individuals of *Pseudoeurycea cephalica*. Examination indicates that it actually represents an undescribed form of the genus *Parvimolge* Taylor, which may be known as

PARVIMOLGE PRAECELLENS, new species

(Figure 1)

Type. An apparently immature female, Museum of Comparative Zoology No. 24701, collected at Hacienda el Potrero, near the city of Cordoba, Vera Cruz, Mexico, on December 24, 1940, by Archie F. Carr.

Diagnosis. A small plethodontid salamander related to *Parvimolge townsendi* by virtue of syndactylous feet, with the partially free digits having pointed tips, and by the presence of conspicuous though small glands about the middorsal line. It differs from *P. townsendi* in larger body size, greater number of teeth, and in having small nostrils. It differs from the only other species assigned to this genus, *richardi*, not only in these characters but also in having conspicuous dorsal glands.

Description. General aspect of body robust. Length of tail approximately six-sevenths of distance from snout to posterior end of vent. Head length (snout to center of gular fold) contained about four times in snout-vent distance; maximum head

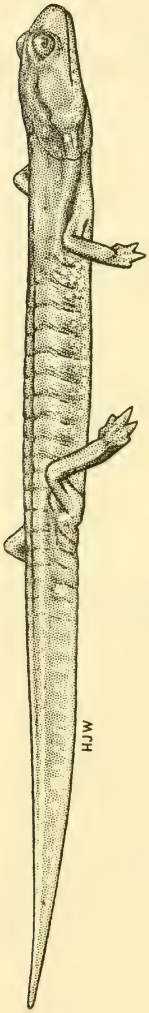

Figure 1. Type of *Parvimolge praecellens*. Actual total length about 65 mm.

width contained in same about five times. Head width three-fourths the snout-gular fold distance and nearly equalling snout-posterior angle of jaw length. Width of an eyelid less than minimum distance between eyelids. Horizontal diameter of eye greater than one and a half times snout-anterior angle of eye distance. Internarial distance four-sevenths the interorbital measurement. Viewed dorsally, the snout is gently rounded, though short in relation to anterior angles of eyes. Canthus rostralis not sharply defined, the area between anterior middorsal line of head and edge of upper jaw being a gradual slope. Nostrils small with nasolabial grooves forking on weakly developed nasolabial protuberances. Snout not projecting beyond tip of lower jaw. Lower jaw semi-oval in outline, ventrally viewed. Lateral extensions of gular fold meet grooves extending from posterior angle of eye and continue dorsally to join the posterior ends of a V-shaped groove originating parietally. Epibranchial ridge extending beyond axillary groove. A deep furrow, perhaps partially due to preservation, follows the middorsal line from scapular region onto tail. The fairly thick skin of dorsum has about fifty small but conspicuous glands (presumably of the "poison" type). These glands appear to be arranged in four irregular longitudinal rows, two of them very close to midline. On the neck the middorsal rows fork and curve laterally. There are a few conspicuous glands on the tail.

Maxillary-premaxillary teeth, counting both sides, total 75. They are practically all of uniform size, those in the premaxillary position not piercing the lip. Eighty-seven mandibular teeth. Prevomerine teeth 20 on right and 23 on left side mostly in double rows which arch very slightly posteriad in approaching the midline from initial points lateral to the small choanae. Distance between prevomerine series at midline is equal to three times the diameter of a choana. Parasphenoid teeth in two oblong patches, each of which has about 70 teeth arranged in diagonal rows. Anteriorly the groups are separated by slightly more than one choanal diameter, posteriorly by about three diameters. Tongue large and free, the fleshy sublingual fold anterior to it well developed.

The moderately chunky body has twelve costal spaces. It is difficult to ascertain whether there are twelve or thirteen costal

grooves because of the contorted condition of the specimen. There are about twenty-two caudal grooves indicated posterior to the vent. Tail quadrangular in cross-section, slightly broader dorsally than ventrally. Throughout most of its length, it is deeper than broad.

Limbs slender and moderately long, hind limb slightly larger and longer than forelimb. Limbs fail to meet by about one costal space when pressed to sides of the body. Hands and feet well developed but not expansive, with slight pads ventrally. The somewhat slender, terminally free digits have pads which are discrete from the palmar pads. Innermost and outermost digits of hand and foot completely enclosed in web. Terminal phalanges of second and fourth toes and second finger free of web, while third toe and finger have almost two phalanges free. Third and fourth toes and second and third fingers noticeably pointed distally, while the second toe appears more rounded. Toes in order of decreasing length: 3, 4, 2, 5, 1; fingers in same order: 3, 2, 4, 1.

In alcohol, the ground color of dorsal surfaces of head, body, tail, and limbs is brownish-black. Ventral surfaces show a faded version of this color with some areas being almost completely unpigmented (gular fold, anterior part of chin, and palms and soles). Underside of tail light brown. Jaw margins appear mottled due to lack of pigment in spots. Bluish-white spots and blotches on lower sides of body and on tail were possibly white in life. A distinct but broken bar of this color on the head between the eyes.

Measurements (in millimeters). Snout-posterior end of vent, *c.* 35; tail, *c.* 30; snout-gular fold, 9.4; snout-angle of jaw, 7.5; snout-anterior angle of eye, 1.6; horizontal diameter of eye, 2.6; head width, 7.0; internarial distance, 2.0; interorbital distance, 3.5; arm, 8.9; leg, 9.4.

Remarks. Before commenting on relationships I wish to place on record some information on *P. townsendi* not obtainable from previous accounts (Dunn, 1922 and 1926; Taylor, 1944). The major source of the data is a series of ten specimens collected at the same time and place as the type of *P. praecellens.* Variational data for the eight alcoholic adults (MCZ 24712-19) are given in Table I. The males have two or three enlarged premax-

illary teeth, prominent mental glands, and well developed nasolabial protuberances, with more truncate snouts and with larger external narial openings than the females (average 0.3 mm. *versus* 0.2 mm.). The parasphenoid teeth groups are separated in half of the eight specimens. Counts of prevomerine tooth rows averaged 5.8 on a side. One male, not included in the average, has these teeth in an irregular patch of ten on each side. UMMZ 111305, an immature specimen (snout-vent, 15 mm.; tail, 13 mm.) from this series, has fewer teeth (prevomerine, 3-5; maxillary-premaxillary, 34; mandibular, 47) and fewer glands (31) than any of the adults of Table I. A female, UMMZ 63944, taken at Cordoba, Vera Cruz, on June 19, 1927, is larger than any recorded specimen, measuring 24 mm. from snout to vent, with a tail of the same length. The ovarian eggs are large, about 0.7 mm. in maximum diameter.

Many minor variations in color were found. The ground color was diverse shades of brown, usually lighter ventrally, and sometimes dorsally, than on the sides. The dark bars described by Dunn are most pronounced on the tail, with the most conspicuous bar or ring occurring at the weakly marked basal constriction of the tail. A herringbone or V pattern can be made out dimly in some specimens held under water; it is apparently the result of concentration of dark pigment in the costal grooves. Most of the specimens have an incomplete light bar between the eyes well indicated, but two do not. Three have some evidence of an additional incomplete anterior interocular bar. In two the rostral region appears as a brilliant white square, due to absence of dark pigment, which is slightly reduced in this area in the other specimens. The limbs, throat, and venter have scattered light, probably pigmentless, spots. Light streaks on the sides are well developed in some, practically absent in others. In one specimen the middorsal area is light brown, contrasted with dark brown dorsolaterally, which in turn is set off by a double row of light streaks or spots on the lower sides. In the same specimen there are striking dorsolateral white patches (apparently pigmentless areas) in the nuchal region.

The tenth specimen from the Potrero series, an adult male measuring about 23 mm. from snout to vent, was stained and cleared (UMMZ S-1556). The testes of this specimen were

relatively enormous and were in the bilobate condition which I have found to characterize the larger, and presumably older, classes of males in *Chiropterotriton* and *Pseudoeurycea*. The more interesting skeletal features are described here. Skull broadly elliptical, maximum width at the otic capsules three-fourths of the premaxillary-occipital condyle distance; frontals and parietals ossified completely to midline; facial lobe of maxilla large, forming with nasal bone a posterior border of nasal capsule; nasal fairly prominent, angling forward medially, about two and a half times as long as broad; prefrontal two-thirds the length and one-half the width of nasal, not participating in the margin of the nasal capsule; basally fused frontal processes of premaxilla diverge considerably forming a wide fronto-premaxillary fontanelle (a tenth of otic capsular width); these processes laterally compressed anteriorly; more posteriorly and dorsally they gradually twist until they appear horizontally flattened where the ends articulate with grooved projections of the frontal bones; two large premaxillary teeth, twenty-three teeth on each maxilla, twenty-eight teeth on each of the well ossified mandibles, eight prevomerine teeth on a side; no median suture between prevomers; parasphenoid teeth in two patches. Skull measurements (mm.) made with ocular micrometer: otic width, 2.9; premaxillary-condylar length, 4.4; prefrontal length, 0.5, width, 0.15; nasal length, 0.75, width, 0.3; fronto-premaxillary fontanelle width, 0.3. Hyoid structures as described by Tanner (1952), but second ceratobranchials definitely osseous or calcified, which is also the condition in the only cleared individual available of *Lineatriton lineola* (UMMZ S-1594). Phalangeal formula of foot, 1, 2, 3, 3, 2; of hand, 1, 2, 3, 2; eight carpals, ulnare and centrale partially fused on both hands, on left hand all ossified to some extent but on right hand radiale and carpal immediately distal to it are cartilaginous. At least seven, probably nine tarsals, four ossified on each side. Atlas weak, not ossified middorsally; only the second vertebra with a noticeable neural ridge. Long, proximally forked ribs present from second to fourteenth vertebra, fifteenth having both transverse processes but no rib. Sixteenth vertebra is the sacral, followed by two transitional postsacral or precaudal vertebrae. Twenty-three caudal vertebrae, the anterior ones with a fin-like process ex-

tending forward from the ventroposteriorly directed haemal process to the anterior edge of the vertebra. Short transverse processes, more laterally angled in the first few caudal vertebrae, more anteriorly directed farther caudad.

This account of the skeletal features is at variance with Taylor's description (1944: 223) on several points, notably the presence of the prefrontal and the ossification of the carpals and tarsals. The latter character may be variable, but the condition in this specimen does not support contrasting the cartilaginous carpals and tarsals of *Parvimolge* with the osseous ones of *Thorius*. This is especially true in view of the fact that Hilton (1946, 1948) has recorded them as cartilaginous in *T. pennatulus*, and since the single cleared specimen referable to *T. dubitus* that I have examined likewise has entirely cartilaginous ones. However, I believe that most of the discrepancies between the two descriptions of *P. townsendi* may be ascribed to different types of material used, and it should also be borne in mind that the foregoing account is based on a single specimen.

TABLE I

Quantitative Characters in Mexican *Parvimolge*

		snout-vent length	tail length	costal spaces	dorsal body glands	premax-maxillary teeth	mandibular teeth
townsendi	R	20-23	20-26		32-42	45-58	54-69
males (4)	M	*22.0*	*22.5*	*3.7*	*39.0*	*50.0*	*61.5*
townsendi	R	19-22	16-21		35-41	48-58	55-73
females (4)	M	*21.0*	*19.0*	*4.2*	*38.0*	*53.0*	*64.0*
praecellens (female)		35	30	1	50	75	87

R, range; M, mean; tooth counts are totals of both sides; measurements in mm.; costal spaces refer to number between adpressed limbs.

Relationships. Parvimolge praecellens is closely related to *P. townsendi,* as indicated by the foot structure, coloration, conspicuous dorsal glands, and shape of tail. A third form, *richardi,* described with reservations as a *Parvimolge* (Taylor, 1949, 1952), lacks the conspicuous glands. This fact, apparent differences in details of the foot, and the enormous disjunction in range — Vera Cruz to Costa Rica — imply that *richardi* is preferably not to be associated with *townsendi* and *praecellens.*

Determining the nature of the affinity between *P. praecellens* and *townsendi* necessitates much more material. However, the more numerous teeth, longer legs, and small nostrils of *praecellens* are probably correlated with its greater size. These characters and the smaller size of the dorsal glands appear to indicate that *praecellens* is less specialized. The morphological and ecological relationship may be of the same general type existing between sympatric large and small species in *Pseudoeurycea* and *Chiropterotriton.* Indeed, in the latter genus, *C. dimidiata* shows seemingly paedomorphic features very like those found in *townsendi.*

That *Parvimolge* is allied to *Lineatriton* as inferred by Tanner (*op. cit.*) is supported by the distinctive osseous character of the second ceratobranchials found to be common to *P. townsendi* and *L. lineola.* Nevertheless, the derivation of *townsendi* and *praecellens* was probably from a less specialized form, perhaps in the *Pseudoeurycea cephalica* group or its ancestral stock. The foot shape in very young specimens of *cephalica,* the presence of irregularly protruding poison glands on the dorsum in some forms of the group, and the guanophore-spotted, brown to black ground color in the group suggest this. The syndactylous foot structure could have become established by a paedogenetic process in *Parvimolge* stock as it differentiated from some such ancestor.

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BREVIORA

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SPEED-INDUCED SKIN FOLDS IN THE BOTTLE-NOSED PORPOISE, *TURSIOPS TRUNCATUS*[1]

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While engaged in a study of the behavior of bottle-nosed porpoises, *Tursiops truncatus* (Montagu), at Marine Studios, Marineland, Florida, over a period of three to four years, the author has observed on hundreds of occasions a remarkable modification of the skin contour of these animals whenever they resorted to rapid movement about the tank (Essapian 1953, p. 399). The circular tank, where the porpoises are on exhibit, is seventy-five feet in diameter and about fourteen feet deep at the center. It houses an average of ten animals.

Generally lost to view due to swiftness of action, this transformation of the skin contour takes place when an animal accelerates its speed in excess of its normal rate, or, when swimming rapidly, comes to a sudden stop. It is then that transverse skin folds may stand out in relief on part of an animal, or may extend over its entire length, from head to tail. The pattern of these formations depends on the speed and sex of the swimming animal, but is not restricted to any age group. The folds may be seen even in an animal only a day or two old.

The skin folds generated by a sudden burst of speed are by far the more common of the two categories, and are usually occasioned when the animals engage in pursuit of one another, are frightened and trying to escape, or when racing for a food fish tossed into the tank. The duration of folds is then conditioned

[1] Contribution No. 751 from the Woods Hole Oceanographic Institution.

by the factors which motivate the animals' movements. In the case of a brief dash, for example, when an animal exerts itself to snatch a fish, the skin folds may last only a second, or even a fraction of a second (Pls. 1 and 2). However, in the case of prolonged rapid movement around the tank, the animals may intermittently exhibit skin folds for a period of one or two or more seconds. Often an animal at play or during the mating season may suddenly leap out of water, exhibiting folds at the peak of acceleration, just prior to its emergence from water, and again after it has reentered the water (Pls. 3 and 4). At this point it may be of interest to note that the fat adult females tend to exhibit fewer folds, but greater in size and at less regular intervals, than are produced in the adult male or in the younger slimmer animals when swimming at comparable speeds. The same female in Plate 4 is also shown in Plate 5; here this animal's folds are shown in a transitory stage, just prior to full acceleration.

The skin folds of the second category occur at less frequent intervals and are of very brief duration. These take place when an animal swimming rapidly without exhibiting any folds comes to an abrupt halt. Then the folds may suddenly be displayed (Pl. 6). The duration of folds of this sort is indicated by the fact that this entire sequence occupies only twelve frames of 16 mm. film at 16 frames per second. This would indicate a total elapsed time of three quarters of a second for the formation and disappearance of folds. Plate 6 is the fourth frame, showing that these folds were fully formed in one quarter of a second.

One feature in the production of skin folds is of particular interest. In an animal maintaining a high and sustained rate of speed the folds are stationary and do not progress wave-fashion. At times, when extremely high speeds are achieved by adult animals, the skin folds tend to slope posteriorly. Observations also indicate that the folds are more likely to occur on ventral and lower lateral surfaces.

While the superficial layer of the porpoise's skin is extremely thin, the blubber is of considerable thickness and is tough and fibrous. In a *Tursiops truncatus* fifteen days old and weighing thirty pounds, the skin, including blubber, is approximately half

an inch thick. In an adult it is nearly one and a half inches thick on the ventral surface. Although normally not apparent to the view or touch, the porpoise's skin is, nevertheless, pliant and loose on the body. This slackness of the skin in a live animal held out of water in a sling is shown in Plate 7.

Discussion

It is tempting to speculate upon the causes of this phenomenon. The answer may lie in the possibility that these folds are caused by the unequal pressure of water upon the body of the animal, in which case the production of folds would appear to be beyond the muscular control of the animal. Clarke and Ruud (1954, p. 144), in discussing different types of marks used in whale marking, say: "... whenever a whale is moving naturally the envelope of blubber is always sliding, more or less, over the contracting and relaxing muscle beneath, so that a mark with stoppers which is set partly in blubber and partly in muscle would almost certainly be worked out." The Marineland porpoises while swimming normally do not display such looseness of skin as is here ascribed to the great baleen whales. However, this similarity in the flexibility of skin in such divergent species suggests that all animals of the order Cetacea may share this characteristic.

These speed-induced folds are to be distinguished from those caused simply by flexure, such as the ones shown in Plates 8 and 9.

Racovitza (1903, pp. 43-44, pl. 3, fig. 17) mentions a group of four *Hyperoodon* (bottle-nosed whales) of which one individual is sketched emerging from water and exhibiting an exaggerated likeness of skin folds on its trunk. Unfortunately the author has failed to explain whether this particular animal was swimming rapidly at the time or whether this deformity in the skin contour was apparent even when the animal had raised itself partly out of water. The author furnished no further explanation beyond expressing his astonishment and a conviction that the animal didn't appear to be sick or emaciated and that the projections on its trunk appeared to be composed of soft material. This animal didn't differ from the three other individuals in any other respect.

At sea, in conditions of greater freedom of movement, the porpoises may exhibit skin folds for more protracted periods than is feasible in the confines of a tank. In any case, these folds should be of interest to hydrodynamicists.

The author wishes to express his deep gratitude to Mr. William E. Schevill for his encouragement, as well as for his helpful suggestions and criticisms of the manuscript. The author is also thankful for the use of a motion picture camera and film which was made available by Mr. Schevill under a contract between the Office of Naval Research and the Woods Hole Oceanographic Institution.

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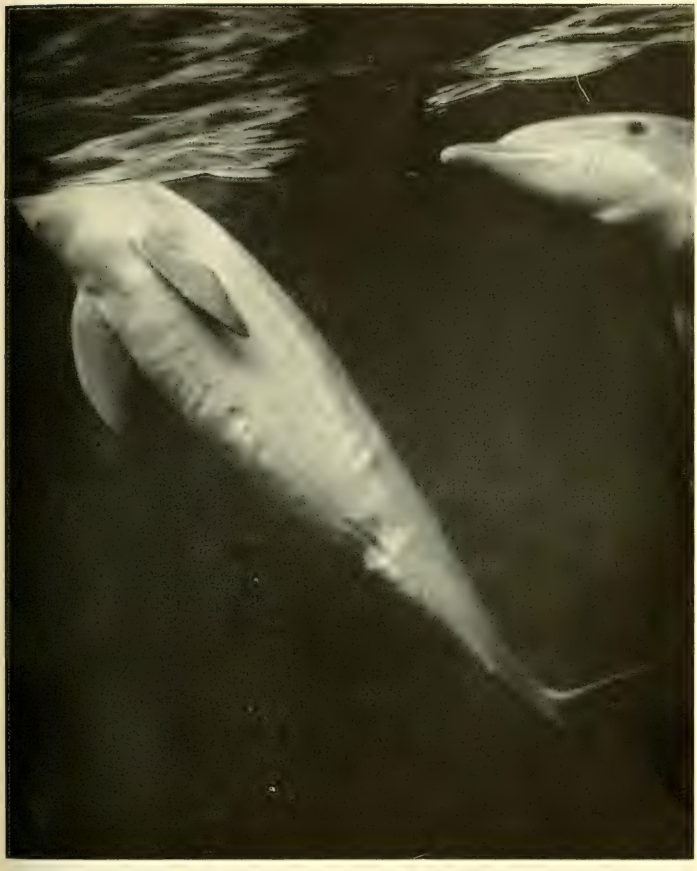
All photographs by courtesy of Marine Studios; the porpoises shown are all *Tursiops truncatus* on exhibition at Marineland, Florida. Plate 7 is from a photograph by Bob Neelands; all the others are by the author.

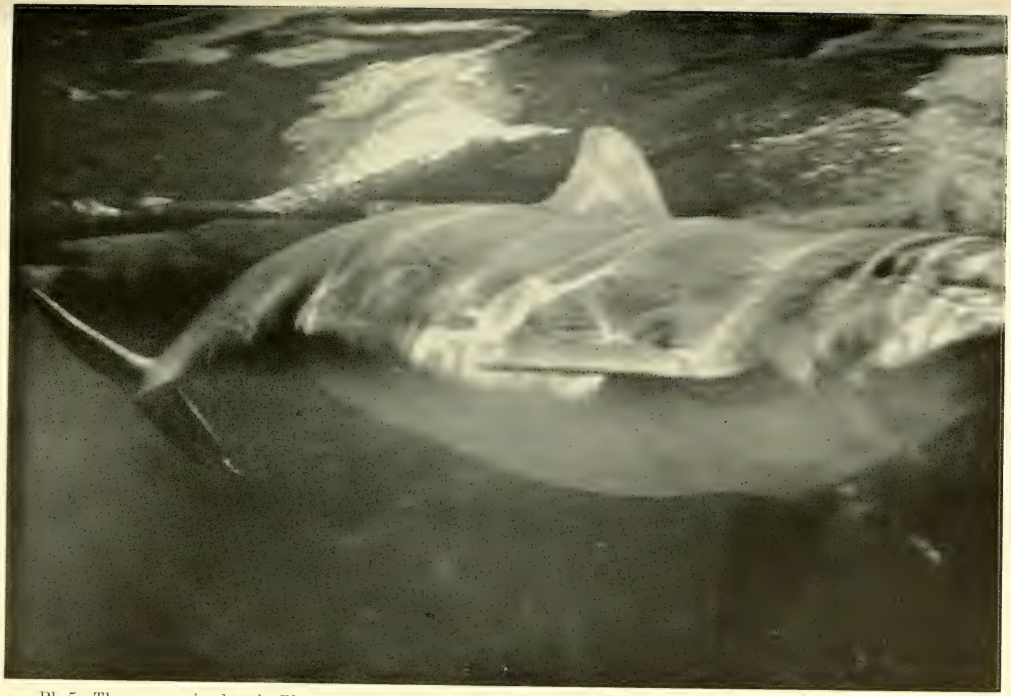
Pl. 1. A female, approximately eighteen months old, displays folds at the peak of acceleration. The fish she has just seized is seen in her mouth.
Photographed at F/3.5 at 1/500 of a second.

Pl. 2. An adult in a state of deceleration, about to seize a fish. Photographed at F/3.5 at 1/250 of a second.

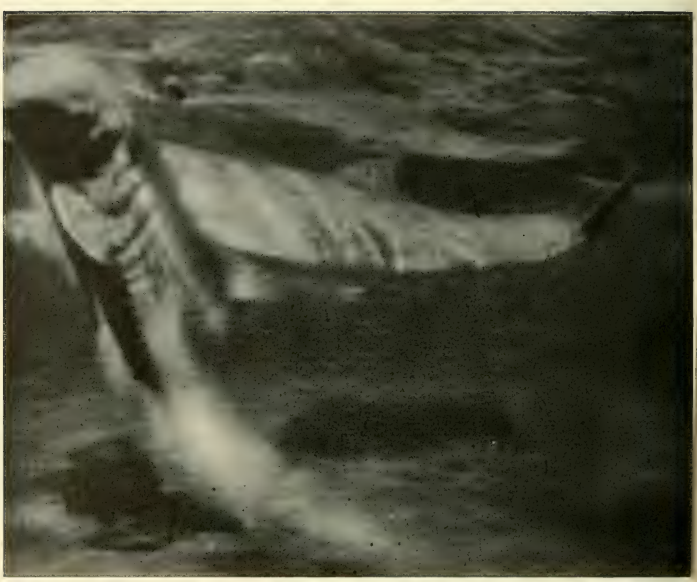


Pl. 3. A female, approximately eighteen months old, about to leap out of the water. Note also the folds on the head of the pursuing five-year-old male.
Photographed at F/3.5 at 1/500 of a second.

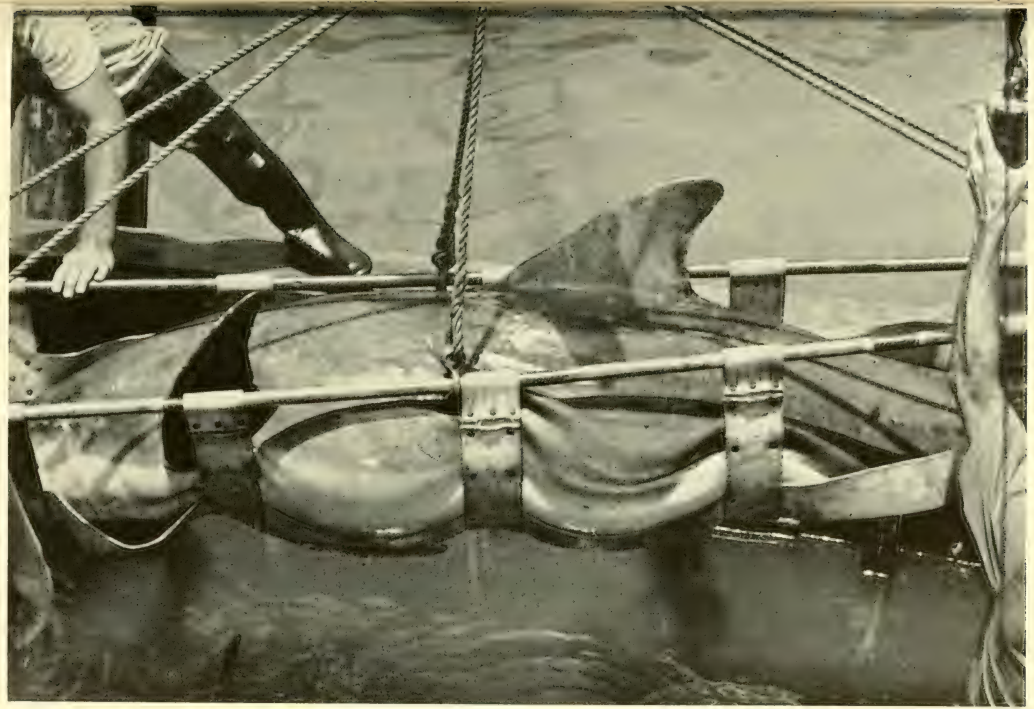
Pl. 4. An adult female displays folds as she reenters the water at completion of a leap.
Photographed at F/3.5 at 1/250 of a second.



Pl. 5. The same animal as in Plate 4 exhibits widely spaced skin folds beginning at the angle of the jaw, prior to full acceleration. As in Plate 1, the irregular light and dark pattern is due to refraction of light through the surface water waves.
Photographed at F/3.5 at 1/250 of a second.



Pl. 6. An adult male displays folds as he comes to an abrupt stop in a vertical position (second porpoise in background shows no folds). Enlarged from 16 mm. film.
Photographed at 16 frames per second.



Pl. 7. A live adult female lifted in a sling displays the extreme looseness of the skin.
Photograph by Bob Neelands.

Pl. 8. Throat folds caused by downward flexion of head (esp. lower jaw). That these differ from the occasional speed folds is shown by the permanent creases between them (seen also on the unflexed throat of the porpoise in Plate 7). Note also the characteristic pigmentation. Photographed at F/3.5 at 1/250 of a second.

Pl. 9. Folds in the neck-shoulder region caused by turning the head sideways. This is the same animal as in Plates 4, 5, and 8. Photographed at F/3.5 at 1/250 of a second.

BREVIORA

Museum of Comparative Zoology

CAMBRIDGE, MASS. APRIL 8, 1955 NUMBER 44

A NEW MUREX FROM MATANZAS, CUBA

BY WILLIAM J. CLENCH

Through the kindness of C. J. Finlay of Varadero Beach, and E. H. Monroe of Cárdenas, Cuba, we have received a series of a new *Murex* which was obtained from shell traps set in 100 fathoms in Matanzas Bay, Cuba.

MUREX (MUREX) FINLAYI, new species

Figures 1-3

Description. Shell reaching 93 mm. (3¾ inches) in length, rather solid in structure and moderately spinose. Whorls ten and moderately convex. Nuclear whorls glass-like and smooth. Color brownish-yellow to brownish-cream with a few spiral threads of a darker brown which follow the crests of the cords. Spire moderately extended. Suture irregular and deeply indented. Aperture subcircular and slightly oblique. Parietal lip glazed, adherent to the body whorl and fairly thick. Palatal lip crenulated and slightly thickened. Siphonal canal greatly extended, sometimes nearly half the length of the shell, usually curved upward and to the left when viewed dorsally. Two or three previously formed stages of the siphonal canal remain as scale-like spines. The sculpture consists of three equidistant varices, each supporting a rather large shoulder spine and maybe two or three smaller spines between the shoulder and the base of the shell. The varices on each whorl are more or less aligned with the varices on the whorl above. Between the varices there are two to four axial ridges which are strongly nodulose. Spiral sculpture consisting of numerous thread-like cords. The varices are formed by two arched plates, the plates on the aperture side being somewhat smaller, the outer (first formed) leaving a flange or

web-like ridge as a crest on the varix. This is usually broken away on the early varices or remains as a series of small blade-like spines.

Measurements

length	width	whorls	
87.0 mm.	30.0 mm.	10	Holotype
93.0	31.0	10	Paratype
85.0	33.0	10	Paratype
82.5	34.0	10	Paratype

Types. Holotype, Museum of Comparative Zoology no. 189939 from shell trap, Matanzas Bay, Cuba, in 100 fathoms. Paratypes from the same locality in the Museum of Comparative Zoology and the collections of C. J. Finlay and E. H. Monroe.

Remarks. This species appears to be rather closely related to both *Murex antillarum* Hinds and *Murex beauii* Fischer and Bernardi. From *M. antillarum* it differs by having fewer and much larger axial costae, having fewer spines, and in possessing the webbing along the varices and the greatly extended siphonal canal. From *M. beauii* it differs by having fewer and much larger axial costae, shorter spines and not having the extensive webbing which characterizes *M. beauii*. This present new species may also be related to *M. aguayoi* Clench and Farfante but it differs from *aguayoi* by being larger, having the diffused brownish-yellow coloration, fewer spines, larger axial costae and by having the webbing on the varices.

The development of the webbing and the greatly extended siphonal canal probably allows these mollusks to exist on a rather soft muddy bottom.

The subgenus *Murex* in which this new species is included, is a very complex group and of very wide distribution in nearly all tropical and south temperate seas.

Murex finlayi Clench. Figs. 1 and 3, paratypes. Fig. 2, holotype. Matanzas Bay, Cuba in 100 fathoms. (All slightly enlarged.)

BREVIORA

Museum of Comparative Zoology

CAMBRIDGE, MASS. June 13, 1955 NUMBER 45

PALAEOTARICHA OLIGOCENICA, NEW GENUS AND SPECIES, AN OLIGOCENE SALAMANDER FROM OREGON.

BY RICHARD VAN FRANK

In 1951 Mr. George R. K. Moorhead, a member of the Salem (Oregon) Geological Society, collected a fossil urodele in a small slab of shale from a locality situated about three miles southeast of Eugene, and about ¼ mile north of Goshen, Oregon. The specimen was sent by Dr. Herman Clark of Willamette University to the Museum of Comparative Zoology for study.

The strata in which the fossil was found are designated by Vokes *et al.* (1951) as post- Fisher and Eugene (Oligocene) plant-bearing tuffs. These strata are described by the authors as "a sequence of apparently water-laid coarse tuffs with interbedded thin layers of carbonaceous gray shale . . . [containing] an abundant flora . . . [of which fifteen species] were determined by Dr. Roland Brown,[1] who assigned a late Oligocene age to the containing strata." Dr. Ralph W. Chaney of the University of California has written me that he too considers the strata to be younger than Eugene or Fisher, and is terming the strata the Willamette formation. On the other hand, Dr. Clark writes that he and Dr. Ewart M. Baldwin of the University of Oregon prefer to assign them to the Eugene formation, although conclusive evidence is lacking. At any rate, all concerned seem confident of the Upper Oligocene age of the deposit. It is the gray shale just mentioned which contains the salamander.

The specimen is about 120 mm. in total length, and lacks a centimeter or so of the tail, the right mandible, most of the ribs, the left scapula and humerus, and parts of the hyoid apparatus. It is black in color, apparently highly carbonized. The skull is

[1] and listed by Vokes *et al.* (1951)

crushed dorsoventrally, and the vertebral column is twisted so that it lies on its side with respect to the skull.

The dorsal surface of the skull when first prepared seemed to be an uneven but continuous structure. Since depressions representing the orbits and the cavum internasale were visible, and the surface was much darker than the matrix, and had the outline of a skull, this dorsal material was thought to be bone in a bad state of preservation. Futile attempts to understand the skull in the light of this interpretation (the sides of the braincase, moreover, appeared to be pressed out and in contact with the maxillae), suggested that research in experimental paleontology might be useful. In this pursuit a skull of a Recent *Taricha granulosa* was decalcified with dilute hydrochloric acid, and then flattened between two glass plates and allowed to dry. The sides of the braincase were still no closer to the maxillae than before. This increased my growing suspicion that the material exposed on the dorsal surface of the fossil skull was not bone, and prompted exploratory probing through the surface. The operation revealed undeniable bone underneath. The removal of most of the matrix from the unexposed side then followed. I believe that the formerly exposed surface was mineralized skin, which had roughly followed the contours of the skull — not revealing, however, any evidence of the taxonomically important frontosquamosal arches. The same dark material is present elsewhere, as revealed by further preparation, and is separated from the bone by about 1 mm. of matrix. Additional evidence of the preservation or influence of soft parts can be seen (Pl. 1, fig. 1) in the thoracic region, where the matrix is unusually dark (and hard); and above the anterior half of the vertebral column, where a possible dorsal crest is preserved.

The specimen is recognized as a urodele by the presence of the ypsiloid cartilage, the long, broad parasphenoid reaching to the foramen magnum, the atlas with an odontoid process, and haemal arches on the caudal vertebrae. The absence of paired tooth rows, and the presence of two longitudinal vomerine tooth rows, diagnose it as a salamandrid. Paroccipital processes, frontosquamosal arches, and an unpaired premaxilla are characters of this fossil as well as, in Recent salamandrids, *Cynops* Tschudi, 1838, *Diemictylus* Rafinesque, 1820, *Euproctus* Gené, 1838, *Hypselotriton* Wolterstorff, 1934, *Pachytriton* Boulenger,

1878, *Taricha* Gray, 1845, and several species of *Triturus*[1] Rafinesque, 1815. The fossil genera *Archaeotriton* von Meyer, 1860, *Heliarchon* von Meyer, 1863, *Oligosemia* Navás, 1922, and *Polysemia* von Meyer, 1860, likewise all seem to have frontosquamosal arches and paroccipital processes, but information on the premaxillae is lacking. The phalangeal formula of the Oregon specimen is 1-2-3-2 (manus) and 1-2-3-3-2 (pes), as also in *Cynops, Hypselotriton, Pachytriton,* and *Taricha. Cynops, Hypselotriton,* and *Diemictylus* (the only Recent American salamandrid genus other than *Taricha*) can be excluded from identification with the fossil because of their relatively long, narrow skull, inconspicuous dorsal opening of the cavum internasale, and failure of the ascending processes of the premaxilla to extend beyond the anterior border of the cavum. *Diemictylus* can be further ruled out by its paired longitudinal ridges extending from the nasals to the posterior border of the parietals, and an abrupt angle in the arches posterior to the frontal-squamosal suture. *Pachytriton* is excluded by its long, narrow skull; a ridge (joining the maxillae across the premaxilla) situated between, and concentric with, the outer tooth row and the anterior border of the vomer;[2] and the very small dorsal cavum internasale opening. *Euproctus* is ruled out by its phalangeal formula of 2-2-3-2, 2-2-3-3-2, an elongated skull with a spatulate anterior end, concave lateral maxillary borders, and the paroccipital processes extending farther back than the occipital condyles. The five or six species of *Triturus* that have complete frontosquamosal arches are excluded by their phalangeal formula, 2-2-3-2, 2-2-3-3-2, and the elongated skull. Of all the known salamandrid genera there is no doubt that *Taricha* is the closest to the fossil. Skull, body and limb proportions are similar, and other important characters are: the frontosquamosal arches; paroccipital processes; large openings of the cavum internasale, the dorsal one bordered anteriorly and laterally by the premaxilla. All these similarities to the Recent *Taricha* species (*torosa, granulosa, rivularis,* and *sierrae*), and the fact that the fossil comes from the present geographic range of one of them (*granulosa*), may justify assigning the fossil to that genus. But some

[1] as used by Wolterstorff and Herre (1935).

[2] vomeropalatine or prevomer.

very important characters distinguishing the fossil from the Recent species lie in the nature of the vertebrae: characters as fundamental as some upon which several genera, known from vertebrae only, have been based. The pelvis is also peculiar, and the tarsal basale count is different, as described below. With these differences, and the belief that if the animal were alive, neoherpetologists would distinguish it generically because of the spinal column, I feel that erecting a new genus for the fossil is justified.

Class AMPHIBIA
Order CAUDATA
Family SALAMANDRIDAE
PALAEOTARICHA, new genus

Genotype: Palaeotaricha oligocenica, new species.

Diagnosis: Precaudal neural spines high, with laterally expanded, broad, rectangular, sculptured, flat tops, which are in contact with each other fore and aft. Fourteen presacral vertebrae. Pelvis with relatively large, knob-like, laterally directed prepubic processes. Tarsal basale formula 1, 2, 3, 4+5. Maxillae extending caudad, united by suture with quadrates.

PALAEOTARICHA OLIGOCENICA, new species

Holotype: University of Oregon Museum of Natural History no. F-5405, a nearly complete specimen.

Collector: Mr. George R. K. Moorhead, August 1, 1951.

Horizon: Upper Oligocene plant-bearing tuffs, not older than Eugene and Fisher formations, the Willamette formation of Dr. Ralph W. Chaney (*in litt.*).

Locality: About 3 miles (5 km.) southeast of Eugene, Lane County, west central Oregon; southeast ¼, sec. 14, T. 18 S, R. 3 W; "about 550 feet east of the Southern Pacific railroad tracks on the south side of a small hill in a cut made for the newly constructed highway near the east end of the overpass over the railroad. This is about 400 ft. north of lat. 44 deg. and 3000 ft. west of long. 123 deg. . . . in the Eugene quadrangle" (Dr. Herman Clark, *in litt.*).

Diagnosis: As for the genus.

Description: Total length (as preserved), 120 mm.; original length, *ca.* 135 mm.; length of skull (anterior end to foramen magnum, dorsal surface), 15 mm.; width of skull (across paroccipital processes), 13 mm.; length and also width of ischiopubis, 6 mm.; length of limb bones: humerus, 9.5 mm.; radius, 7 mm.; ulna, 7.5 mm.; digit 3, manus, 6.5? mm.; femur, 9 mm.; tibia, 5.5 mm.; fibula, 6 mm.; digit 3, pes, 6 mm.

The paroccipital processes are large and are produced laterad, abutting the squamosals from behind. The frontosquamosal arches are complete and robust. The dorsal aperture of the cavum internasale is long and wide, and is bordered anteriorly and laterally by the ascending processes of the premaxilla. The vomerine opening of the cavum internasale is large (probably in part artificially); it lies wholly within the vomer. The anterior border of the vomer is an arc of a circle (roughly), with no sharp breaks in its periphery. No teeth are preserved, but the vomerine tooth rows are evident though crushed and incomplete.

The vertebrae are relatively shorter than in *Taricha*. There are 14 presacral vertebrae (13 in *Taricha*). Even the atlas has an expanded top, which, however, narrows anteriad. Instead of the dorsal surface of the atlas sloping downward anteroventrally as in *Taricha*, in *Palaeotaricha oligocenica* it is horizontal for most of its length, then there is a short ventrally directed slope toward the anterior end, and then a sudden vertical drop to the condylar facets (Pl. 1, figs. 2, 3). The neural spines of the caudal vertebrae lack the expanded tops.

Five[1] thoracic ribs of the left side are exposed in good condition (Pl. 1, fig. 1; Pl. 3, fig. 1). All but the caudalmost have conspicuous uncinate processes, which, in successively posterior ribs, become shorter and more distal.

The great length of the scapula suggests that the suprascapula was ossified (or calcified). There are four digits in the manus. The phalangeal count is 1-2-3-2, which, together with the carpal basale formula (1+2, 3, 4), is the same as in *Taricha*.

The pelvic girdle has floated free and, with the limbs, is fairly well preserved as a unit. The pelvic girdle is apparently a highly ossified and coössified structure. Zones of weakness may perhaps exist anteriorly between left and right halves, and between the

[1] Some of the things that look like ribs in Plate 1, figure 1 are phalanges of the left manus.

pubes and ypsiloid cartilage. The latter is heavily ossified (or calcified; there is no obvious difference in preservation between it and any other part of the skeleton). About 5 mm. of it are preserved, of which 2 mm. are proximal to the bifurcation. The prepubic processes are rounded and robust. They project laterally and apparently slightly posteriad in *P. oligocenica,* but anterolaterad in *Taricha,* where they are also less demarcated from the pubes. There are five digits in the pes; the phalangeal count is 1-2-3-3-2. The tarsal basale formula is 1, 2, 3, 4+5, whereas the *Taricha* specimens have 1+2, 3, 4, 5.

On the whole the skeleton gives the appearance of having great strength, with the girdles and limb elements all well ossified, and the top-heavy neural spines.

Discussion: The elongation of the maxillae seems to be a primitive character of Salamandridae. In all the fossil genera of which the skulls are known the maxillae articulate with the quadrates: *Archaeotriton, Brachycormus* von Meyer, 1860, *Heliarchon, Oligosemia, Palaeopleurodeles* Herre, 1941, and *Polysemia* (all Miocene; *Oligosemia* also Oligocene). In three of the more primitive Recent salamandrids, *Pleurodeles* Michahelles, 1830, *Salamandrina* Fitzinger, 1826, and *Tylototriton* Anderson, 1871, the maxillae may very nearly or actually touch the quadrates. In the *Palaeotaricha oligocenica* specimen, although the maxillae clearly articulate (fuse?) with the suspensoria, the indistinct quadrate-squamosal sutures make it difficult to see exactly which suspensorial element is involved with the maxillae. I have assumed that the quadrate is involved, because of the condition in the forms just cited. Other than the maxillae, the *P. oligocenica* skull seems to fall within the variation of the skulls of the several *Taricha* species. In *T. granulosa* the vomerine tooth rows generally diverge slightly, from the anterior to the posterior ends; in the other species they are parallel or very slightly divergent for most of their length, then suddenly they are strongly divergent for the remaining ¼ or ⅓. There is, however, a good deal of individual variation and intergradation between these tooth-row patterns. The available skulls of *T. sierrae* and *T. rivularis* (three of the former, four of the latter) seem to be rather similar, and to stand apart from the skulls of the other two species. For one thing, the skull of *rivularis* and *sierrae* tends to be somewhat deep and domed, in contrast to the

more-or-less flattened and widened roof of the others. *T. rivularis* and *sierrae* tend to have the dorsal opening of the cavum internasale especially long and wide. In anterior view it is seen as a notch whose bottom lies ventral to the dorsal border of the nares, which is not the case in *torosa* or *granulosa;* nor does it extend so far forward in the latter two species. The above characters are more pronounced in *rivularis* than in *sierrae,* but the following character is equally developed in the two. The ventral (vomerine) opening of the cavum internasale is greatly elongated — roughly the size and shape of the dorsal opening — and extends beyond the anterior border of the vomer into the premaxilla. In the other species this aperture is usually circular or slightly elliptical, and is wholly situated within the vomer. In about ten alcoholic specimens each of *rivularis* and *sierrae,* and many more of *torosa* and *granulosa,* this difference is corroborated. In one skull of *granulosa,* however, there is a very small, extra, opening into the cavum internasale anterior to the vomer-premaxilla border — a feature that would be very difficult to note in an alcoholic specimen. It would be very interesting to know whether the elongated aperture is an evolutionary advance (cf. *Palaeotaricha*) or is primitive (cf. primitive extant genera of salamandrids, which have the premaxilla paired, and some have the aperture extremely large).

A full description of the skull of *T. torosa* is given by Bolkay (1928) (under the name *Diemyctylus* [*sic*] *torosus;* his specimen could be a *granulosa,* judging by the vomerine tooth rows), as well as descriptions of the skulls of most of the Recent salamandrid species.

The condition in the vertebrae — the expanded tops — of *Palaeotaricha oligocenica* is not only different from that in *Taricha,* where the neural spines are high but narrow, but quite different from any other urodele vertebrae that I can find. Among Recent salamandrids *Tylototriton* comes closest in this respect, *fide* Herre (1949) and corroborated in the specimens available to me. But in *Tylototriton* the expansion is much less prominent, and the width decreases anteriad; the tops of the spines are, however, sculptured, and they do contact in series, as in *P. oligocenica.* The closest approach of all seems to be in the Miocene *Chelotriton* Pomel, 1853, which has a broad top on the neural spine also. But (at least in the specimen figured by Herre,

1949, p. 225, fig. 8) the anterior half of the spine comes to a rounded point, and the posterior end is bifurcated by a wedge-shaped notch. Thus it seems that the *Chelotriton* vertebra has merely a greatly expanded neural spine, and is not fundamentally different from that of most salamandrids (e.g. *Taricha*, Pl. 1, fig. 5). Now arises the question (considering the absence of visible sutures between the vertical and horizontal portions of the *P. oligocenica* neural spines) of whether we have a structural series of increasingly expanded neural spines — *Taricha, Tylototriton, Chelotriton, Palaeotaricha* — or whether the latter is not in this series, the spinal expansions being dermal plates plastered on top (as suggested by the sculpturing). I favor the latter view: the expansions *look* like dermal plates; and, of course, the series just given has only descriptive validity.

The uncinate processes of the *P. oligocenica* ribs are longer than in the Recent *Taricha* specimens at hand, but these structures are quite variable in individual salamanders. In three specimens of *Taricha g. granulosa* I have seen, one has uncinate processes on ribs 2 and 3 on the right side; on rib 2 only, on the left. Another has uncinates on ribs 2 to 4 on both sides; the third specimen has them on 2 to 7 on both sides. One specimen of *Cynops pyrrhogaster* has uncinates on ribs 2 to 6 on the left side, on 2 to 7 on the right; another has no uncinates at all. And so it goes. In all these cases the larger and more fully ossified the individual, the greater the number of uncinate processes. In nearly every specimen I have seen there are incipient uncinates on the first one or two ribs distal to the last one that has a distinct uncinate process.

The tarsal basale formula in *P. oligocenica* — 1, 2, 3, 4+5 — contrasts with 1+2, 3, 4, 5 in the Recent *Taricha, Chioglossa* Barboza du Bocage, 1864, *Salamandra* Laurenti, 1768, *Mertensiella* Wolterstorff, 1934, and *Pleurodeles* Michahelles, 1830, while *Salamandrina* with four toes on all feet apparently has 1, 2, 3, 4, and all other genera have 1+2, 3, 4+5, *fide* Bolkay (1927), and in agreement with additional material seen by me.

It is interesting to note that the carpus, as compared with the tarsus, is apparently much more nearly constant throughout the Salamandridae. As figured by Bolkay (1927) and corroborated and extended by the specimens available to me, the carpus has

basales 1+2, 3, 4, prepollex basale,[1] centrale, radiale, intermedium, and ulnare, in all genera. The latter two may or may not be fused, but usually are: in one specimen of *Triturus vulgaris* the intermedium of the right manus is separate; the left is fused with the ulnare.

While the observations of Hilton (1948) agree in general with those of Bolkay and me, Hilton illustrates various cases of fusion of carpal and tarsal elements, and extra elements (such as the non-fusion of tarsal basales 4 and 5 in a specimen of *Cynops pyrrhogaster*). In the light of Hilton's data, the difference between the *Palaeotaricha* and the *Taricha* tarsus may not be significant. Yet it must be pointed out that all of the 16 specimens of *Taricha* at hand have the same tarsal and carpal structures.

The large size and knob-like shape of the prepubic process of *P. oligocenica* also seem to be unique. When these processes exist in the Recent specimens at hand, they are always smaller, more pointed, and directed at least partly anteriad. Nor do any of these Recent pelves have the fusion of the left and right halves to the extent seen in *P. oligocenica*, where scarcely even a raphe remains of a former suture.

From all appearances *Palaeotaricha* is not ancestral to *Taricha*, but is its nearest relative. I do not feel that *Palaeotaricha* helps determine the further affinities of *Taricha*, for the one character that might seem to indicate relationship with other genera — the elongated maxillae in *Palaeotaricha* — is merely primitive and not unexpected.

Material examined: I have been fortunate in being able to examine skulls and skeletons of every genus of Recent Salamandridae, with the single exception of *Pleurodeles*, and to see alcoholic specimens of nearly every species of all genera. It must be emphasized, however, that except for 16 specimens of the three species of *Taricha*, in no case have I seen more than two skeletons. Hence I do not feel that my knowledge of intraspecific variation is sufficient for more than tentative authority on the above comparative skeletal studies.

Note on the stereophotography

The ventral view of the *P. oligocenica* skull (Pl. 2, A) was

[1] Bolkay follows another usage in calling this element carpal basale 1; and what he calls 2 is here called 1+2. Likewise he designates the prehallux basale as tarsal basale 1, and 1+2 as 2.

made by Dr. Donald Baird, of this Museum, and myself, with a binocular (stereoscopic) microscope, and a Leica 3C camera fitted with a Leitz Focaslide and Leitz Micro-Ibso. The ocular lens of the latter was inserted alternately into the two tubes of the microscope, and exposures were made in the two positions of the apparatus, at an interocular distance of 2½ inches. The latter refers to the positions of the Focaslide, which was used because it was found that the side telescope of the Micro-Ibso was not sufficiently accurate for the depth of focus required. This method may be theoretically superior to the tilt method usually used, since it takes care of matters of interocular distance and angles more easily. But for subjects as large as the present ones considerable trial-and-error choice of microscope lenses was necessary to get the entire image into view.

All the other figures were made with a Kodak 2-D 5″ x 7″ view camera fitted with a 135 mm. lens, and mounted on a pivoted arm. One picture of each stereoscopic pair was taken vertically, the other at 7° from the vertical. Exposures were 20 seconds at f. 22, using panatomic film, and illuminated by two 100- and one 200-watt bulb with reflectors, each about 2 feet from the subject.

ACKNOWLEDGMENTS

I am very grateful to Dr. Donald Baird for his help and the use of his equipment in the photography; Mr. Benjamin H. Banta, Stanford University, for the gift of a number of specimens; Mr. Charles M. Bogert, American Museum of Natural History, for the loan of material; Dr. Ralph W. Chaney, University of California (Berkeley), for stratigraphic information on the fossil locality, and for permission to use his unpublished term, "Willamette formation"; Dr. Herman Clark, Willamette University (now retired), for sending the *Palaeotaricha* specimen, and for providing and permitting me to quote his information on the fossil locality; Dr. Max K. Hecht, Queens College, New York, for much valuable help; Mr. Arthur Loveridge, Museum of Comparative Zoology, for permission to examine and skeletonize a number of specimens; Dr. Richard M. Ritland, College of Medical Evangelists, for the use of material from his personal collection; Dr. Jay M. Savage, Pomona College, for valuable help; and above all to Dr. Ernest E. Williams, Museum of Comparative Zoology, for first suggesting that I undertake this study, and for much help and continued advice.

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EXPLANATION OF PLATES

PLATE 1

Figs. 1, 2, 4. *Palaeotaricha oligocenica*, holotype, University of Oregon Museum of Natural History, no. F-5405. Fig. 1. Entire specimen (except end of tail). Skull seen ventrally, spinal column from right side. Fig. 2, *A*, *A'*. Stereograph of vertebrae 1 to 3, left side. Fig. 4. Vertebrae 10 to 12, left side. The neural spines of all precaudal vertebrae are bent sinistrad. Figs. 3, 5. Vertebrae of a *Taricha torosa*. Fig. 3. Vertebrae 1 and 2. Fig. 5. Vertebrae 9 and 10. *od*, Odontoid process. Fig. 1 x 1; figs. 2-5 x 6.

PLATE 2

Palaeotaricha oligocenica, skull of holotype. *A*, *A'*, stereograph of dorsal view. *B*, *B'*, ventral view. *a*, Atlas; *dci*, dorsal opening of cavum internasale; *en*, external naris; *f*, frontal; *fsa*, frontosquamosal arch; *fv*, foramen vestibuli; *hy*, parts of hyoid apparatus; *in*, internal naris; *lj*, lower jaw; *m*, maxilla; *n*, nasal; *nld*, nasolacrimal duct?; *oc*, occipital condyle; *op*, occipito-petrosal; *os*, orbitosphenoid (the white dot may be the optic foramen); *p*, parietal; *pam*, palatine part of maxilla; *pm*, premaxilla; *poc*, paroccipital process; *prf*, prefrontal; *ps*, parasphenoid; *pt*, pterygoid; *q*, quadrate; *s*, squamosal; *vci*, vomerine opening of cavum internasale; *v*, vomer. All figures x 2¼.

PLATE 3

Palaeotaricha oligocenica, holotype. Fig. 1. Right pectoral girdle and limb, and ribs 3 to 7. Forearm and manus in dorsal view, other parts in right side view. *bc 1+2*, Carpal basales 1+2; *bc 3+4*, carpal basales 3+4; *h*, humerus; *mc 1*, metacarpal 1; *ppb*, prepollex basale; *r*, radius; *ra*, radiale; *r6*, rib 6; *s*, scapula; *u*, ulna; *ul+i*, ulnare + intermedium.

Fig. 2. Pelvic girdle and limbs. Pelvis and left limb in ventral view, right limb (left side of photograph) in dorsal view. *bt 4+5*, Tarsal basales 4+5; *c*, centrale; *f*, femur; *fe*, fibulare; *fi*, fibula; *i*, intermedium; *phb*, prehallux basale; *prp*, prepubic process; *t*, tibia; *ti*, tibiale; *y*, ypsiloid process. Both figures x 2¼.

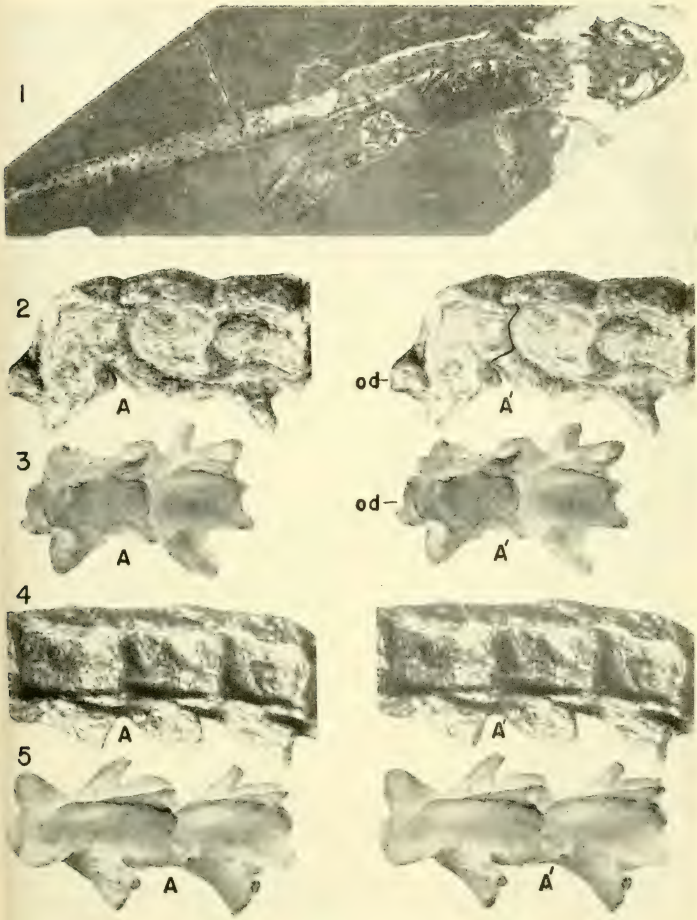

PLATE 1

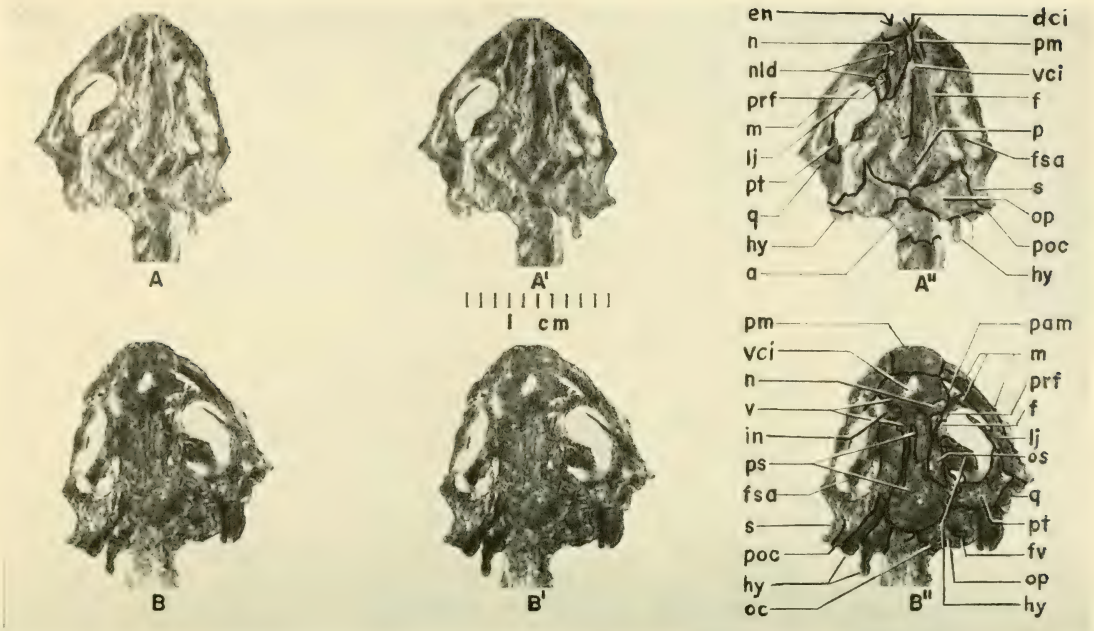
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PLATE 2

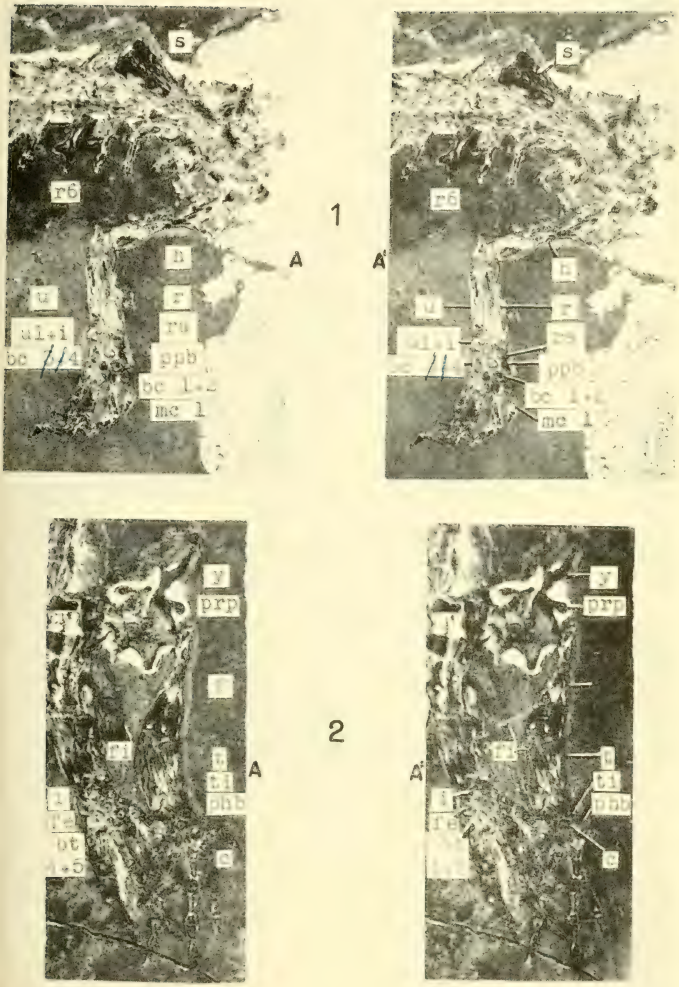
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PLATE 3

BREVIORA

Museum of Comparative Zoology

CAMBRIDGE, MASS. June 24, 1955 NUMBER 46

CAVE-FOSSIL VERTEBRATES FROM CAMAGUEY, CUBA

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Of all the Cuban provinces, Camaguey is the least known in regard to its former and present vertebrate fauna. With this fact in mind the junior author, in January of 1952, visited the Sierra de Cubitas in Camaguey with the purpose of locating cave-fossil material.

The Sierra de Cubitas is a range of low (maximum altitude of 750 feet) Tertiary and Cretaceous limestone hills running northwest to southeast along the northern half of Camaguey. The hills rise abruptly from the flat serpentine Camaguey savanna, and are covered by one of the few remaining tracts of tropical forest in the province. Two caves were visited by the junior author. Both are located on the south slope of the hills, at the Trinchera de Martin Castillo (the site of a battle during the war against Spain), which is about seven kilometers west of the village of Banao. The first cave was the Cueva del Indio (referred to as Cave 1 henceforth in the text), an extensive cave that is on occasion visited by excursionists from the city of Camaguey. The second cave lies a short distance east of Cave 1, and will be designated as Cave 2, since it bears no known name.

The present entrance to Cave 1 is a broad, high-domed opening which is continuous with the large chamber from which the deeper passages of the cave extend. Due to the ample entrance the entire chamber is well within the twilight zone. The floor of the chamber has been excavated for bat guano. The entrance to the cave is higher than the chamber floor, and consists of rocks fallen from the eroded cave front. The red soil of the chamber

was damp, but at higher levels near the entrance the soil was dry. However, during rains, water enters the cave and material has been deposited at different levels near the entrance. All of the fossil material collected was found as surface litter deposited at different points near the cave entrance. Material was extremely abundant, any handful from the surface yielding many bones and snail shells. Collections were made at random from the many pockets where the litter consisted almost exclusively of bones and snail shells.

In the case of Cave 2 erosion has cut back so that it has exposed to direct sunlight a former high dome, about seventy feet high) with massive stalactites and stalagmites along the sides. In this cave, digging for bat guano had only ceased two years previous to the time of the visit and consequently the entire floor of this shallow cave is covered with the mounds of red litter that were screened out by the guano collectors and the material washed out from these mounds by the rain. The abundance of bones in this cave can only be described by saying that there are millions. To walk in any part of this cave is to walk upon a floor of bones and snail shells. Collecting in this cave was essentially the same as in Cave 1, but of a greater volume. The material was scooped up at random from the mounds and from the floor. Due to the little time available no adequate investigation was done in any of the more protected parts of the cave where material was still undisturbed by the guano collectors.

The snail shells collected were kindly identified by Dr. W. J. Clench of Harvard University. Eight species were found and according to Dr. Clench all the species are at present common in Camaguey.

MATERIAL COLLECTED

Class MAMMALIA

Order INSECTIVORA

Nesophontes micrus. Represented by one maxilla, eight mandibles, three femora, and one humerus from Cave 1, and by two partial skulls, eight mandibles, and three femora from Cave 2. This species was first described from the provinces of Matanzas (Allen, 1917b), and later from Oriente (Anthony, 1919) and Isla de Pinos (Allen, 1918). In addition there is material in the Museum of Comparative Zoology from Las Villas and Pinar

del Rio, and in the United States National Museum from Habana province. The present material from Camaguey completes the record and demonstrates that the species existed throughout Cuba.

Solenodon cubanus. Represented by a portion of one mandible and six isolated teeth from Cave 1. At least two individuals are represented in the material collected. This species is known today as a living animal only from Oriente (*S. poeyi* is considered a subspecies, following Aguayo, 1950). It has previously been found fossil in both Oriente (Allen, 1918) and Pinar del Rio (Aguayo, 1950). It apparently also occurred in the Sierra de Trinidad in the province of Las Villas up until the middle of the nineteenth century (Gundlach, 1895). The present material agrees well with fresh specimens from Oriente, but differs by somewhat larger size and robustness. Since the species was differentiated into two subspecies in Oriente, and the animals from the Sierra de Trinidad appear to have been distinct in color from the Oriente forms, it is possible that the Camaguey material may represent a different subspecies. However, the material available is not adequate to determine this.

Order CHIROPTERA

Macrotus waterhousei. Represented by two mandibles from Cave 1, and a portion of one skull and three mandibles from Cave 2. This species was previously known from Isla de Pinos and all the provinces except Camaguey. Apparently a common and widely distributed form.

Monophyllus cubanus. A single mandible from Cave 2. A single periotic bone from Cave 2 is also allocated to this species. All recent records of this bat appear to be from Oriente, but Gundlach (1868, pp. 48, 49) records it from Rangel in Pinar del Rio.

Brachyphylla nana. Represented by two mandibles from Cave 1, and nine partial skulls and 18 mandibles from Cave 2. This species was previously known from all the provinces of Cuba except Camaguey and Isla de Pinos. A common and widespread species.

Artibeus jamaicensis. Represented by five partial skulls and two mandibles from Cave 1, and eight partial skulls and twenty-

six mandibles from Cave 2. Presumably known from all the provinces of Cuba and from Isla de Pinos, though we have been unable to find any definite record for Matanzas. Several specimens of this species were shot in Cave 1. A very common and widespread species.

Phyllops falcatus. Represented by two partial skulls and three mandibles from Cave 1, and ten partial skulls and twelve mandibles from Cave 2. Previously recorded from Oriente, Las Villas, Matanzas, and Pinar del Rio, but probably occurs throughout Cuba and Isla de Pinos. None of the fossil material from Camaguey represents *P. vetus,* still known only as fossil from Oriente (Anthony, 1919).

Erophylla sezekorni. Represented by two mandibles from Cave 1, and two rostra and seven mandibles from Cave 2. Previously known from Habana, Las Villas, and Oriente, it is probably rather widespread in Cuba.

Phyllonycteris poeyi. Represented by one mandible from Cave 1, and by ten rostra and fifteen mandibles from Cave 2. Previously known from Pinar del Rio, Habana, Matanzas, Las Villas, and Oriente, and is thus a widespread species.

Natalus primus. Represented by a single mandible and a fragmentary rostrum from Cave 2. This species was first described as a fossil from Oriente by Anthony (1919), but it is also known from Las Villas (Koopman, unpublished). Our record is the first from anywhere else and the first rostral material, the other finds consisting entirely of mandibles. Known only as fossil, this species was apparently rare but probably fairly widespread.

Tadarida brasiliensis. (We follow G. M. Allen, 1911, in considering *T. muscula* a subspecies of *T. brasiliensis.*) Represented by two rostra and two mandibles from Cave 2. Previously known from all the provinces of the Cuban mainland. Evidently a common and widespread form.

Tadarida molossa. Represented by one rostrum and one mandible from Cave 2. These appear to be the first Cuban specimens of this species with definite locality data, *T. macrotis,* a synonym, having been described only from "the interior of Cuba" (Allen, 1911). Apparently a very rare or local form.

The geographic data for the bats were obtained from Miller (1904), Allen (1911), Peterson (1917), Anthony (1919) and from the specimens in the collections of the Museum of Compara-

tive Zoology at Harvard, the American Museum of Natural History in New York City, and the United States National Museum in Washington, D. C.

Order RODENTIA

Boromys offella. Represented by one mandible and two isolated teeth from Cave 2. Originally described as fossil from Oriente (Miller, 1916) it has since been recorded from Las Villas (Allen, 1918), Pinar del Rio (Museum of Comparative Zoology specimens), and Isla de Pinos (Allen, 1918). It apparently was formerly a widespread species.

Boromys torrei. Represented by one mandible from Cave 1 and by two rostra, fifteen mandibles, and three isolated teeth from Cave 2. Ten auditory bullae from the latter deposit are also tentatively referred here. This species has previously been found in Oriente (Anthony, 1919), Las Villas (Museum of Comparative Zoology), Matanzas (Allen, 1918), and Pinar del Rio (Museum of Comparative Zoology), and also on Isla de Pinos (Allen, 1918). Evidently this was formerly a widespread and common species.

Capromys (*Mystateles*) *nana.* Represented by a single tooth from Cave 1, and by one rostrum, four mandibles, and six isolated teeth from Cave 2. This species is known as a living animal only from the Cienega de Zapata (Allen, 1918 and 1942), and as a fossil was only known from Matanzas (Allen, 1917a), Las Villas (Allen, 1918), and Oriente (Anthony, 1919). Apparently originally rather widespread.

Capromys (*Mystateles*) *prehensilis.* A single rostral fragment from Cave 2 is best allocated to this form. The species occurs in Pinar del Rio, Habana, Matanzas, and Las Villas, and is represented by a subspecies on Isla de Pinos (Mohr, 1939). A widespread form in western and central Cuba.

Capromys (*Geocapromys*) *columbianus.* Represented by one mandible and five isolated teeth from Cave 1, and by three mandibles and five isolated teeth from Cave 2. This species was originally described from cave-fossil material from Las Villas (Chapman, 1892), and it has since been recorded from Oriente (Anthony, 1919), Matanzas, Pinar del Rio, and from Isla de Pinos. Apparently once a common and widespread form.

Rattus. Represented by many partial skulls, mandibles, and

posteranial skeletal parts from Cave 1 and Cave 2.

Mus. Skeletal remains from both Cave 1 and Cave 2. Not as abundant as the *Rattus* remains.

A great deal of posteranial and some cranial material, particularly of rodents, remains unidentified.

Class AVES

The bird remains collected at Cave 1 and Cave 2 were not identified.

Class REPTILIA
Order SQUAMATA

Anolis lucius. A few dentaries and maxillary elements from Cave 1 are referable to this species. In Cave 2 only a single parietal of this species was found. This is, at present, a common lizard inhabiting the limestone walls at the entrance of the caves.

Anolis equestris. Represented by the proximal portion of a lower jaw and portion of one maxilla from Cave 2. This species was observed inhabiting the forest outside of the caves.

Leiocephalus sp. A large dentary that seems to represent a species of *Leiocephalus* was collected at Cave 1. Part of a maxilla from Cave 1, and a dentary and a maxilla from Cave 2 are also referable to this genus.

Tarentola americana. This rare gekkonid species is represented by a single dentary from Cave 2.

Alsophis angulifer. A few vertebrae from Cave 2 are referable to this species of snake.

Some cranial and posteranial reptilian material from Caves 1 and 2 remains unidentified.

Class AMPHIBIA
Order ANURA

Hyla septentrionalis. Cranial and posteranial elements of this common tree frog were the most abundant non-mammalian remains to be found in Cave 1 and Cave 2. Some of the bones found appeared to be more rugged and larger than those of the two skeletons prepared for comparison.

DISCUSSION

Most of this collection probably represents the result of owl predation. However, it is probable that some of the material does not represent owl pellet remains but rather bones washed into the cave, the remains of animals that took refuge in the cave, or remains of native kitchen middens.

None of the material was stratified, all of it having been intermixed by the diggings for bat guano. It is therefore impossible to establish the relative age of the fossils. The presence of two introduced European species — *Rattus* and *Mus* — proves that at least part of the material collected is post-Columbian in age. However, the presence of species now extinct in Cuba — *Nesophontes*, *Natalus primus*, *Boromys*, and *Capromys* (*Geocapromys*) *columbianus* — or extinct in Camaguey — *Solenodon* and *Capromys* (*Mystateles*) *nana* — suggests an early pre-Columbian age for some of the material. There is no evidence of difference in age or type of deposition between Cave 1 and Cave 2.

The collections from these caves also establishes the presence of a number of species previously not recorded from Camaguey.

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BREVIORA

Museum of Comparative Zoology

CAMBRIDGE, MASS. JULY 12, 1955 NUMBER 47

A NEW SPECIES OF WHIPTAILED LIZARD (GENUS *Cnemidophorus*) FROM THE COLORADO PLATEAU OF ARIZONA, NEW MEXICO, COLORADO, AND UTAH

BY CHARLES H. LOWE, JR.

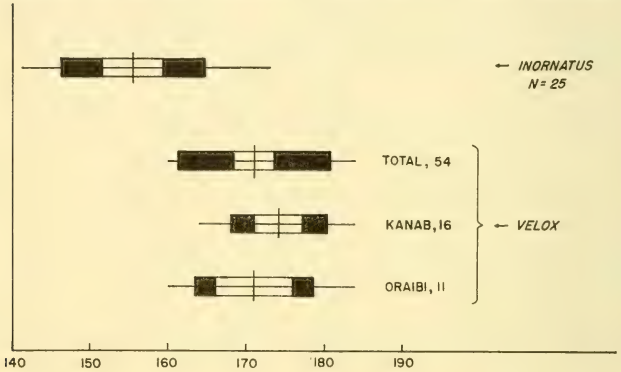
Department of Zoology, University of Arizona

In a previous paper it has been shown that the holotype of the form of *Cnemidophorus* described by Burger (1950) as *C. sacki stictogrammus* represents a distinct species and is not a member of the sympatric species *C. sacki* to which it was assigned. In the present paper *C. sacki innotatus* also described by Burger (*op. cit.*) in the same study is similarly shown to be a different species from *C. sacki;* it is *Cnemidophorus velox* described by Springer (1928) as *C. gularis velox.* Both of these forms described by Burger (*stictogrammus,* and *innotatus* = *velox*) are sympatric with *C. sacki* in Arizona.

Neither Burt (1931) nor Burger (1950) properly assigned Springer's (1928) material. Springer (*op. cit.*) designated no specimen as type and his four original specimens were cotypes. Burger (*op. cit.*) accepted M.C.Z. No. 37208 as lectotype of *velox* by Burt's (1931:124, 127) designation; this specimen is also accepted here as the type specimen. However, Burger continued the error of the identity of this specimen with the statement (1950:3) that "It is an example of *C. inornatus,*" and proceeded to redescribe *velox* as *C. sacki innotatus.* M.C.Z. No. 37208 is not an example of *C. inornatus* (= *perplexus* auct.) as is shown by analysis of characters of scalation; it is an example of *C. velox* Springer. Burger (1950:4), in redescribing *C. velox* as *C. sacki innotatus,* states that "Springer (1928) may have had specimens of this lizard [*innotatus*] on hand when he described *velox;* in

some respects his description fits it better than *inornatus.*" This is quite true.

During the past few years I have collected topotypes of *C. velox* from Oraibi, Arizona, and Pueblo Bonito (in Chaco Canyon National Monument), New Mexico; both of these localities were spoken of by Springer (1928) as localities from whence came his type series of four specimens of *C. gularis velox* (Oraibi, 3; Pueblo Bonito, 1). The topotypic material of *C. velox* is species-identical with a series of topotypes of *C. sacki innotatus*



Comparison of *C. inornatus* Baird and Girard and *C. velox* Springer. The white rectangles enclose two standard errors of the mean. One white plus black rectangle encloses one standard deviation. The differences between the two species are highly significant. The differences between the two populations of *C. velox* are not significant. Data from Tables 1 and 2.

Burger that have also been collected for this study in the vicinity of Kanab, Utah, the type locality. Moreover, this species (*C. velox*) has been collected together with *C. sacki* at several localities in Arizona, as further discussed below.

In Table 1 are presented results of statistical analysis of characters of scalation of *C. sacki*, *C. inornatus*, and *C. velox*. Table 2 presents a comparison of *C. inornatus* with samples of *C. velox* from the two type localities involved: (a) the type locality of

Springer's (1928) *C. gularis velox* (Oraibi, Navajo County, Arizona), and (b) the type locality of Burger's (1950) *C. sacki innotatus* (vicinity of Kanab, Kane County, Utah). Both of these type localities are in Pinyon-Juniper Woodland. Only one other species of lizard in the genus *Cnemidophorus* is known to occur in the vicinity of Oraibi or Kanab; this is *C. tigris* which is represented by the northern subspecies *C. tigris septentrionalis* Burger which is a valid and especially distinctive race. From analysis of scalation and of color pattern it is clearly evident that *C. gularis velox* Springer (1928) = *C. sacki innotatus* Burger (1950).

The question now arises as to whether *velox* is or is not conspecific with *sacki* (= *gularis*) as now understood. This question has been unequivocally answered by having found *velox* and *sacki* to be sympatric over a wide area where the ranges of the two overlap in Arizona. At such localities each maintains its own respective genetic differences without evidence of gene exchange. One is able to shoot adults of both species (*velox* and *sacki*) while standing in the same spot at localities where they are sympatric (e.g., Pinal Mountain, Gila County; Prescott Mountains, Yavapai County; Oak Creek, Coconino County). See Table 1 for certain similarities and differences in morphological characters of these two species.

Cnemidophorus velox is a whiptail of Woodland and Coniferous Forest habitats. It is the common striped whiptail of the so-called Colorado Plateau of northern Arizona and New Mexico, southern Utah and Colorado. It exceeds in both altitude and north latitude the ecologic distribution of *C. sacki* in Arizona and New Mexico. *C. sacki* does occur (marginally) in Coniferous Forest and occurs in Pinyon-Juniper Woodland. Thus on outlying mountain masses south of the main body of the Colorado Plateau, the two species are found to be sympatric in Woodland and Coniferous Forest habitats in central Arizona, near the northern limit of the geographic distribution of *C. sacki* and the southern limit of *C. velox*.

The much larger *C. velox* is also specifically distinct from the small *C. inornatus* (= *perplexus* auct.). These two species resemble one another superficially in color and pattern, particularly in the total absence of light spots on the body of both juvenile and adult; small individuals of the two species have been most

commonly confused. The highly significant difference in the dorsal scalation of these two species is shown in Table 2 and Figure 1. The *species* rather than *subspecies* relationship of the two is also clearly evinced by the fact that the much larger bodied form (*C. velox*) is the one with the northward distribution (on the Colorado Plateau) while the smaller sized form (*C. inornatus*) is a predominantly Mexican population ranging only into the southern United States. This relationship of surface-volume ratio to environmental temperature is opposite to that which is to be predicted on the basis of the Bergmann Principle applied to ectotherms (see Fitch, 1940:123; Cowles, 1945). Also *C. inornatus* is a species primarily of grasslands and plains and does not reach the higher elevations attained by *C. velox* in Coniferous Forest habitats (7000-8000 ft.) in the United States.

The following diagnosis of *C. velox* Springer (1928:102) is based upon the type specimen, topotypes recently collected, and additional series recently collected in Colorado, Utah, Arizona, and New Mexico.

Cnemidophorus velox Springer
Plateau Whiptail

Type specimen. No. 37208, Museum of Comparative Zoology. Collected in August, 1928 by Stewart H. Springer. The type locality is here restricted to Oraibi, Navajo County, Arizona. See discussion below.

Diagnosis. A moderately-sized species of *Cnemidophorus* characterized by: (1) a maximum snout-vent length of approximately 85 mm.; (2) 6 or 7 longitudinal light body stripes, with the seventh (vertebral) stripe, when occurring, less distinct than the remaining stripes; (3) total absence of light spots in the dark fields on the body; (4) ground color of the upper surfaces of the body black to blackish-brown; (5) ventrum immaculate whitish very faintly tinged with bluish; (6) distal portion of tail light bluish in adults and bright blue in juveniles; (7) 171.1 $\pm$ 1.3 (160-184) scales on the midline from occiput to rump; (8) 73.1 $\pm$ 0.63 (63-85) scales around midbody, excepting the enlarged ventrals; (9) 7.7 $\pm$ 0.16 (5-10) scales between paravertebral stripes at midbody; (10) mesoptychial scales conspicuously enlarged and abruptly differentiated from the adjacent granu-

lar scales of the gular fold; (11) postantebrachial scales *not* greatly enlarged (not enlarged as in *C. sacki*) to 4 or more times the size of adjacent scales.

Distribution. On the so-called Colorado Plateau of northern Arizona and New Mexico, southern Utah and southwestern Colorado. The range extends southward on outlying mountain ranges to at least central Arizona and to central or southern New Mexico. The relationships to *C. velox* of a group of apparently non-spotted, small, mountain-dwelling populations of northern Mexico is currently being investigated.

Comparisons. C. velox is distinguished from *C. sacki,* with which it is sympatric, by characters of color pattern and body size as well as scalation (see Table 1). *C. velox* is smaller, non-spotted, has a black to blackish-brown ground color, and a light bluish tail (adults) that is bright blue in juveniles; *C. sacki* is larger, spotted, has a light brown to dark brown ground color, and a brownish tail.

C. velox, while superficially resembling *C. inornatus* in color pattern, is clearly distinguished from *inornatus* in body size and scalation (see Tables 1 and 2). *C. velox* is considerably longer, larger, and with a greater number of dorsal scales.

Discussion. Smith and Taylor (1950:184) give the type specimen of *C. gularis velox* Springer as Butler University No. 848, thereby following Burt (1931:124, 127) while at the same time accepting and using Burger's (1950:3) nomenclature (*C. inornatus* with *C. gularis velox* a synonym) based on the type specimen in question as Harvard M.C.Z. No. 37208. The problem is not so simple as stating or assuming that Butler Univ. No. 848 is now M.C.Z. No. 37208.

Mr. Arthur Loveridge of the Museum of Comparative Zoology has kindly checked details of the record concerning M.C.Z. No. 37208. He has recently informed me that the M.C.Z. has had no recorded dealings with Butler University, that the museum register records this specimen as having been received from one J. Piatt on January 11, 1934, and that it is the holotype of *Cnemidophorus gularis velox* Springer, collected at Lee's Ferry, Arizona, August, 1928, by Stewart H. Springer. The data on the specimen label gives the same information, including "Gift from J. Piatt, Indiapolis[*sic*]." The specimen in question (No. 37208) is recorded as the holotype of *Cnemidophorus gularis*

velox Springer in the second list of type material in the M.C.Z. (Barbour and Loveridge, 1946:92); this action, with type locality given as Lee's Ferry, Arizona, antedates the action of Smith and Taylor (1950) who restrict the type locality to Pueblo Bonito, New Mexico. While it is possible that M.C.Z. No. 37208 could be Butler Univ. No. 848, there is nothing in the record to so indicate. As far as can be now determined, there is no record at Butler University for the final disposition of this specimen or any of the others in the type series of *C. gularis velox* Springer. Dr. N. E. Pearson, Head of the Department of Zoology of Butler University, informed me on December 1, 1954, that he was unable to find either a record or specimen used by Springer in describing *Cnemidophorus gularis velox*.

In a paper entitled "An annotated list of the lizards of Lee's Ferry, Arizona," Springer (1928) described *Cnemidophorus gularis velox* and recorded the collection of his four specimens (cotypes) as follows: Oraibi, Arizona, 3; Pueblo Bonito, New Mexico, 1. My study of M.C.Z. No. 37208 shows it to be a specimen of *C. velox* described by Springer, and not a specimen of *C. inornatus* (= *perplexus* auct.) as is stated by Burger (1950:3).

I consider the holotype of *C. velox* (= *C. gularis velox*) Springer to be M.C.Z. No. 37208, the type locality of which is here changed to Oraibi, Navajo County, Arizona, rather than Lee's Ferry, Coconino County, Arizona (*fide* Springer, 1928). Ample topotypes are now available from Oraibi and vicinity. Burger (1950) concurs in the citation of M.C.Z. No. 37208 as the type of *C. g. velox* Springer. The later action by Smith and Taylor (1950:184) in their restriction of the type locality to Pueblo Bonito, San Juan County, New Mexico, is not acceptable. Dr. Hobart Smith has recently concurred in this opinion (*in litt.*).

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TABLE 1.

Characteristics of scalation, pattern, and body size of *Cnemidophorus velox* Springer, *C. inornatus* Baird and Girard, and *C. sacki exsanguis* Lowe, based on representative samples from north of the Mexico-U.S.A. International boundary. O-R, occiput to rump; *around*, around midbody excepting ventrals; P-V, between paravertebral stripes.

Characteristic	N	*C. velox*	N	*C. sacki exsanguis*	N	*C. inornatus*
Scales O-R	54	171.1 ± 1.3 (160-184)	24	175.2 ± 1.5 (160-185)	25	155.8 ± 1.8 (141-173)
Scales *around*	55	73.1 ± 0.63 (63-85)	24	72.1 ± 1.1 (62-82)	25	63.7 ± 0.94 (55-75)
Scales P-V	55	7.7 ± 0.16 (5-10)	24	4.6 ± 0.24 (2-8)	25	8.1 ± 0.10 (5-11)
Postantebrachials		Not greatly enlarged to 4 or more times size of adjacent scales.		Greatly enlarged to 4 or more times size of adjacent scales.		Not greatly enlarged to 4 or more times size of adjacent scales.
Spots		Absent		Present		Absent
Stripes		6 or 7		6		6 or 7
Snout-vent L. (*ca.* maximum)		85 mm.		100 mm.		70 mm.

TABLE 2.

Comparison of *middorsal scales* from occiput to rump (scales O-R) of *C. inornatus* Baird and Girard with *C. velox* Springer from its type locality (Oraibi, Arizona), and with *C. velox* from the type locality of *C. sacki innotatus* Burger = *C. velox* (Kanab, Utah). The difference between the two species (*velox* and *inornatus*) is highly significant; the difference between *velox* (Oraibi) and *velox* (Kanab) is not significant. Data graphed in Figure 1.

Species	Mean and Standard Error	3.	2.
1. *C. inornatus* (Ariz., New Mex.)	155.8 ± 1.8 N = 25	m_1—m_2, 18.3 *t*, 7.6 P, < .001	m_1—m_2, 15.2 *t*, 4.9 P, < .001
2. *C. velox* (Oraibi, Arizona)	171.0 ± 2.5 N = 11	m_1—m_2, 3.1 *t*, 1.0 P, .3	
3. *C. velox* (Kanab, Utah)	174.1 ± 1.6 N = 16		

BREVIORA

Museum of Comparative Zoology

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NOTES ON AMERICAN EARTHWORMS OF THE FAMILY LUMBRICIDAE. I-II.

By G. E. GATES

Information as to variation of taxonomically important characters in our little known endemic lumbricids hitherto has been lacking. Some now can be recorded through the kindness of Dr. G. E. Pickford, Prof. Walter Harman, Ottys Sanders, and others. The author's thanks are extended to all those who have supplied or loaned material.

I

EISENIA LÖNNBERGI (Michaelsen) 1894

Mt. Carmel, New Haven, Conn. In wet soil at bank of river, Oct. 28, 1928, 1-0-3. Dr. G. E. Pickford.

Cockaponsett, Conn. Near Indian caves, Nov. 9, 1941, 0-0-1. Dr. G. E. Pickford.

Cockaponsett State Forest, Conn. In wet soil (pH *ca.* 5.5) under water-logged logs at edge of lake (water level low leaving muddy shore with stumps), Oct. 6, 1940, 0-1-2. Dr. G. E. Pickford. (Clitellate specimens were copulating when taken.)

Meshomasic State Forest, Conn. By stream (pH *ca.* 5.0), April 28, 1935, 0-0-3. In soil (pH *ca.* 5.0) in bank of stream below Hypochilus colony, Nov. 4, 1935, 0-0-1. Dr. G. E. Pickford.

Woodbridge, Conn. In marshy soil of alder copse near Baldwin's Road, Wehawaug River valley, Oct. 21, 1928, 1-0-2. Same locality, in marshy soil (pH *ca.* 6.2), Oct. 16, 1928,

1-0-1. At edge of small pond, June 14, 1931, 0-0-1. Dr. G. E. Pickford.

Tallulah Falls, Georgia. In ravine, in sandy loam in seep of stream, July 27, 1931, 1-0-13. J. M. Valentine per Dr. G. E. Pickford. ("Abundant" according to collector.)

Mt. Vernon, Virginia. From nearby swamp, April 22, 1917, 0-0-1 (macerated). Walter D. Webb Jr., per Prof. E. Carpenter. (Two other Virginia specimens, kindly loaned by Prof. Harman, have been examined.)

External characteristics. Length, 77-104 mm. (Conn.), -130 mm. (Georgia). Diameter in clitellar region which is flat on ventral side, 6-8 mm. Body becomes transversely rectangular in cross section posteriorly. Segments, 114-134 (*cf.* Table). Pigmentation in dorsum, dark, rather nondescript, at least in present condition, possibly lighter in viii-xi near mD. Prostomium epilobous; tongue short, open or closed (3 specimens). Setae begin on ii (33) on which all are usually present, located at four corners of the body posteriorly where $AB <$ or ca. $= CD$, $BC < AA$, AA ca. $= DD$. Nephropores recognizable only on a few of the segments, first seen on iv, usually in or close to CD on iv-xiii, between levels of female and male pores on xiv-xvi, elsewhere in median part of BC or dorsal to D but without regular alternation or segmental symmetry, occasionally in DD on one side even in xiv-xvi. First dorsal pore on 4/5 (32), 6/7 (1).

Spermathecal pores on 8/9-10/11 (30 specimens), 8/9-11/12 (1), just lateral to mD, each on a small tumescence and in a longitudinal groove so that four small tubercles seem to be present on each intersegmental furrow. Female pores at eq/xiv just lateral to *B*. Male pores each at bottom of a slight transverse depression, at eq/xv and much nearer *B* than *C*.

Clitellum red (formalin preservation), saddle-shaped, reaching ventrally nearly to *B* or to tubercula pubertatis, 23/24-eq/xxx (1), xxiii-xxx (5), xxiv-xxx (22). Tubercula pubertatis longitudinally placed, rather broad bands just lateral to *B*, on xxvi-xxviii (31), occasionally continued onto anterior half of xxix and/or posterior half of xxv but there gradually narrowed, markedly protuberant (several) and then sometimes with *b* setae on median face, the *b* setae on several other specimens slightly

displaced mesially. Epidermis in *AA* of clitellar segments about as thick as in genital tumescences.

Genital tumescences present (or recognizable?) only on three worms, around *c-d* of viii (1), of xi-xii (1), around *a-b* of x (1), of xx-xxx (1, ex copula), of xxiii-xxx (1, ex copula), of xxiii (1). The *a* and *b* setae of xx-xxx (1), xxi-xxx (1), xxii-xxx (8), xxiii-xxix (10), xxiii-xxx (11), xxiv-xxix (1), xxiv-xxx (5), xxvi-xxviii (1) are deeply retracted into the parietes and the margin of each follicle aperture is protuberant as a slight but obvious annular tumescence. The *a* and *b* setae of x (3) and/or the *c* and *d* setae of x (7) likewise are retracted and follicle apertures have an annular tumescence. Male pore tumescences slight, median to the pore, usually not reaching either intersegmental furrow, occasionally quite unrecognizable.

Internal anatomy. Septa 12/13-14/15 muscular and increasingly thickened posteriorly.

Oesophageal wall slightly thickened posteriorly in x but without any trace of sacs. Calciferous glands large, in xi-xii, not quite reaching insertion of 12/13. Intestinal origin in xv (33). Gizzard in xvii-xviii, some special muscularity in xix in at least one of the worms. The typhlosole begins abruptly in region of xxiv-xxvii or may be recognizable from *ca.* xx as a flat horizontal band gradually thickened and heightened posteriorly. The shape in cross section behind xxviii is for a time like that of an inverted T but the ventral margin gradually becomes more rounded. The typhlosole is high, nearly reaching floor of gut and when the ventral portion is cut off readily separates into two lamellae, the space between with only a few delicate fibres and a little granular matter. The end, rather abrupt, normally is in region of c-cxv (*cf.* Table I).

The subneural trunk, adherent to nerve cord, usually is fairly large and filled with blood but when empty may be unrecognizable. A large vessel passes up from each extra-oesophageal trunk in vicinity of 9/10. Last hearts in xi (33), usually small and empty. Hearts of x often smaller than those of ix. Hearts of vi or vi-vii sometimes also are small. Nephridia have been found only from iii posteriorly (lacking in ii?). Nephridial ducts apparently pass into parietes in region of *B*.

Seminal vesicles three pairs, in ix, xi-xii, those of xii the larg-

est, those of ix the smallest though still of fair size. Male deferent ducts appear to be slightly thickened in the entalmost portion and rather sinuous but without definite loops on posterior faces of septa just behind the funnels. Spermathecal ducts slender, usually longer than the ampullae which are in ix-xi or ix-xii. Ovisacs small, slightly lobed in each adult.

Glandular tissue is present on the parietes median to *A* (and also lateral to *B*) in a band that extends from xxx to or well towards xxii and mesially nearly to the nerve cord. Similar tissue is present on the parietes laterally in xi-xii of one worm but none is present over the male pore tumescences in any of these specimens.

Follicles of the retracted genital setae are markedly protuberant into the coelom, thick and opaque, only the ental end of a shaft visible at inner end of a follicle. Such follicles (*c* and *d*) were found in x of several specimens on which annular tumescences of the apertures had not been noticed prior to dissection.

Juveniles. Glandular tissues on the parietes were unrecognizable but the *a* and *b* follicles of xx-xxx were conspicuously protuberant into the coelom, especially in the middle of the series.

Abnormality. Male funnels of x though plicate and iridescent in one sexual worm are only about half the size of those in xi.

Each spermatheca of ix of one worm has two ampullae both of which contain sperm.

The ampullae of the spermathecae in xii of the octothecal worm are smaller than those in the other segments and are transparent though other spermathecae are distended and with spermatozoal iridescence.

Brown bodies. Ovoidal, spheroidal and discoidal bodies of various sizes, in a posterior amputee, fill coelomic cavities of several segments just in front of the anus. These bodies sometimes contain setae and apparently differ from the usual "brown" bodies only in being white.

Habitats. E. lönnbergi, in Connecticut, according to Dr. Pickford (*in lit.*) inhabits wet places, commonly along with *Eiseniella tetraedra* (Savigny) 1826 and "is not found in cultivated soils, fields, forest soils, nor in stagnant boggy ground but rather in banks of streams and rivers or in marshy backwaters." Presence in soil with a pH of 4.5 also was mentioned by Dr. Pickford.

Life history. Reproduction presumably is biparental ordinarily as evidence of sperm maturation and/or reception was recognized in all but one of the adults. The exceptional worm (April 28) obviously had not yet copulated nor matured sperm though the clitellum was fairly well developed (presexual clitellate). Marked iridescence in distended spermathecal ampullae and on male funnels, like the large soft seminal vesicles, in the other two April and the June worms, just as clearly indicated sexual maturity and copulation. Iridescence on male funnels and in spermathecae of July specimens (Georgia) was much less marked. Spermathecal ampullae of two of those worms were filled with a watery fluid or pink jelly in which there was no iridescence, and ovisacs were occupied by a brown granular debris. The slight iridescence on male funnels and in spermathecae of some of the fall worms (Oct. 10, 21, 28) and especially the brown debris filling the seminal vesicles again indicated a postsexual state. Two *ex copula* individuals (Oct. 6) and another (Nov. 4) that had recently copulated show that reproduction may occur in the fall also. Slight iridescence on the male funnels showed that some sperm already had been matured in the aclitellate (Oct. 6) worm which had not yet copulated. Whether a summer period of sexual inactivity separates spring and fall breeding seasons remains to be determined.

Parasites. Nematodes were present in the coelomic cavities of x-xi of one worm.

Fairly large cysts, presumably of gregarines, are present in seminal vesicles of several worms where they are quite obvious as soon as the specimen is opened. Other cysts are present in the parietes of several specimens, some even recognizable from the exterior with which they seem to be in communication by a minute aperture. Large, transparent cysts in coelomic cavities of last few segments (several worms) have two hemispheroidal opaque bodies each with a single nucleus. Smaller opaque cysts are numerous in the same region.

Ovoidal bodies with an opaque center and a transparent periphery are attached each by a slender and relatively very long stalk to the parietes of segments behind xix (one worm).

Remarks. The coloration in vivo, according to Dr. Pickford (*in lit.*) is a peculiar, dark grey, irregularly interrupted by

lighter areas and so characteristic as to enable easy recognition of the species in the field. Pigment may have been lysed at maturity in the dorsum of viii-xii in one worm, just as happens in *Eisenia foetida* (Savigny) 1826, and may have been leached in others by the formalin. The coloration in some of the Georgia specimens was about the same in the ventrum as in the dorsum and was not externally distinguishable from the darkening of unpigmented worms that takes place, in certain conditions, in formalin.

The clitellum of one *ex copula* worm is markedly tumescent, perhaps more so than on any other specimen. The tumescence of the clitellar region of the copulatory partner is however only very slight.

Whether glandular tissue on parietes lateral to *B* in clitellar region is associated with GS follicles and tumescences or with tubercula pubertatis is unknown.

An anal segment had been reconstituted after amputation (or autotomy) in 16 specimens. Regeneration of a tail in this species, as in *Lumbricus terrestris* L., may not take place.

In the evolution of *E. lönnbergi* a pair of spermathecae opening on 7/8 has been lost. Two pairs opening on 9/10-10/11 have been acquired. The genetic factors responsible for addition of a pair of spermathecae in xii of the octothecal mutant presumably have been involved in the evolution of various lumbricid species.

II

Eisenia carolinensis Michaelsen 1910

Helodrilus (*Eisenia*) *carolinensis* Michaelsen 1910, Ann. Mus. Zool. St. Petersburg, 15, p. 15. (Type locality, presumably Fayetteville, North Carolina. Type, in Hamburg Mus., intercepted in a plant shipment at Hamburg.)

Eisenia pearsei Stephenson 1933, Proc. Zool. Soc. London, 1932, p. 935, fig. 28. (Type locality, Durham, North Carolina. Types, 13, in Brit. Mus.)

Eisenia carolinensis, Cernosvitov, 1942, Proc. Zool. Soc. London, 111, (B), p. 222. (14 specimens, 5 immature, from Durham, N. C., in Brit. Mus.)

Chapel Hill, North Carolina, April 19, 1932, 0-0-1. J. M. Valentine per Dr. G. E. Pickford.

Highlands, North Carolina. In peaty leaf mould (pH 4.5) among tree roots under leaves near path on way to Primeval Forest, July 26, 1931, 0-0-1. In pocket of sandy black soil (pH 5.0) under dead leaves by stream in woods on path to Primeval Forest, July 25, 1931, 0-0-2. In leaf mould and sandy loam (pH *ca.* 5.0) near path leading up to Whiteside Mountain at altitude of *ca.* 4500 ft., August 21, 1932, 0-0-1. Dr. G. E. Pickford.

Linville, North Carolina. In earth and leaf mould (pH between 5.0 and 6.0) by stream in ravine, near road at 4000 ft. and 14 miles from Blowing Rock, July 31, 1931, 1-0-3. Dr. G. E. Pickford.

Indian Gap (now Newfound Gap, in Great Smoky Mountains), Tennessee. In leaf mould and loamy soil (pH between 5.0 and 6.0) among tree roots and rotting wood, at *ca.* 5000 ft., July 30, 1931, 0-0-2. Dr. G. E. Pickford.

Chilhowie, Virginia. In pocket of loamy soil among grass roots at bank of stream by bridge at *ca.* 3500 ft., about 10½ miles on road to Whitetop Mountain, July 21, 1931, 0-1-4. Dr. G. E. Pickford.

(Several other Virginia worms, loaned by Prof. Harman, also have been examined.)

Tickfaw River Valley, Louisiana, 0-7-0-0. (Mus. Comp. Zool. No. 2061.)

External characteristics. Length, 80-99 mm. (normal worms only). Diameter, 5-7 mm. Segments (122?) 135-142 (*cf.* Table). Pigment unrecognizable in alcoholic and most formalin material. A light red characterizes dorsum of region in front of xv in freshly preserved material (Harman's), and at parietal incisions circular muscle layer looks red. Body four-sided posteriorly, the dorsal surface slightly wider than the ventral, the sides slightly concave. Prostomium epilobous (28 specimens), tongue open and usually quite short. Setae begin on ii (28) on which all usually are present, one pair at each angle of the body posteriorly where $CD <$ or ca. $= AB$, $BC < AA < DD < \frac{1}{2}$C. Nephropores first recognizable on iii, usually close to or dorsal to *D* on iii-vii, viii or ix, slightly lateral to *B* on xv-xvi (16) and thence posteriorly often at that level but occasionally in

DD, the location often not the same on opposite sides of the same segment. First dorsal pore on ?5/6 (2), 5/6 (25).

Spermathecal pores on 9/10-10/11 (27), close to mD, each in a quite small tumescence. Female pores equatorial, just lateral to *B,* on xiv. Male pores equatorial, on xv, each in a transverse slit-like depression in median portion of *BC.*

Clitellum red (formalin preservation) or white (one alcoholic), saddle-shaped, reaching ventrally nearly to *B,* on (xxiii)xxiv-xxxi (3), (xxiii)xxiv-xxxi(xxxii) (1), xxiii-xxxi (3), xxiii-xxxii /2 (1), xxiii-xxxii (1), xxiv-xxxi (6), xxiv-xxxii/2 (1), xxiv/2-xxxii/2 (2), xxv-xxxi (1). Epidermis in *AA* of clitellar segments thickened but not as much as in genital tumescences. Tubercula pubertatis lateral to *B,* band-like but not as wide as in *E. lönnbergi,* on xxvii-xxix (25), perhaps occasionally extending slightly onto xxx and/or xxvi.

Genital tumescences conspicuous and transversely elliptical, always including both *a* and *b* setae, on ix (1), xi (3), xii (3), xvi (2), xvii (21), xviii (5), xx (7), xxi (16), xxii (1), xxiii (1), xxiv (3), xxv-xxx (27), xxxi (14), xxxii (2), xxxiii (1), *c-d* of xxiv (1). Each may have a greyish translucent central area. Posterior tumescences are not delimited laterally from the clitellum. Male pore tumescences restricted to xv (7), extending onto xvi but not onto xiv or only very slightly (5), extending well into xiv and xvi (7).

Internal anatomy. Septa 12/13-14/15 muscular and increasingly thickened posteriorly. Longitudinal muscle band at mD and peritoneum apparently without pigment.

Oesophagus with no sacs in x. Calciferous glands as in *E. lönnbergi* Michaelsen 1894, large, moniliform, in xi-xii, separated by a deep constriction, the posterior gland often not reaching insertion of 12/13. Gizzard in xvii-xviii, muscularity occasionally extending slightly beyond insertion of 16/17 or 18/19. Intestinal origin in xv (18). Typhlosole begins in region of xxii-xxvi, abruptly or rather gradually as a flat band that shortly becomes vertical, reaching a height of 1½-2 mm. and to or nearly to floor of gut, thickly lamelliform, the interior with only a few delicate fibres and some granular debris. The highest anterior portion, as in *lönnbergi,* may have a deep groove on the ventral face. The end normally is in region of xcvii-cv (*cf.* Table II).

Subneural trunk quite small, adherent to nerve cord, some-

times quite unrecognizable. Last hearts in xi (18), the hearts of x-xi usually slenderer than the ones in ix, none found in v. Nephridial ducts pass into parietes in the *b* gap.

Seminal vesicles three pairs, in ix, xi-xii (18, including the juvenile), those of xi sometimes (5) smaller to much smaller than the others. Male deferent ducts apparently slightly thickened in the entalmost portion which is in 2-4 very short loops crowded close together on the posterior face of the septum behind the funnel, recognizable (as in *lönnbergi*) on parietes into xv. Spermathecae with short ducts not confined to parietes, ampullae in ix-x (18, including the juvenile).

Follicles of the genital setae (those in copulatory tumescences) enlarged, obviously protuberant into coelom but not as long (nor as muscular?) as in *lönnbergi*. Glands, atrial and such as are present on the parietes in *lönnbergi* and species of *Bimastos* are lacking.

Abnormality and *Variation*. Spermathecal ducts of the Chapel Hill worm are confined to the parietes and each ampulla is deeply constricted by the septum, the portion anterior to the septum of quite different appearance from that behind. Seminal vesicles of ix are lacking. Genital tumescences are present on xxxi-xxxiii as well as on ix and in addition were developed around *c-d* of xii.

Genital tumescences in front of xv and behind xxx otherwise were only on worms from Linville and Chilhowie.

Regeneration. Many of the worms clearly are posterior amputees (*cf*. Table II) and two others may be. No regeneration, except reconstitution of an anal segment, had taken place although the amputation in some cases probably had not been recent.

Life history. Reproduction presumably is biparental as sperm had been matured and/or received in each adult. Spermatophores (at 25/26 in *BC*, on xxviii at mV) and brilliant iridescence in spermathecal ampullae presumably indicated recent copulation by a July 31 worm (Linville) in which no iridescence was recognizable on male funnels. Funnel iridescence was brilliant on the April (Chapel Hill) and four July 21 (Chilhowie) specimens. Male deferent ducts were iridescent in the April worm which is the only one with maximal clitellar tumescence. The single aclitellate individual (July 21, Chilhowie) with dis-

coloration in dorsum of clitellar segments, slight iridescence only at periphery of male funnels and empty spermathecal ampullae clearly is postsexual. Spermathecal ampullae were empty in two worms (Linville) and iridescence was lacking in opaque matter in ampullae of another as well as in transparent watery content of two, in all of which funnel iridescence was not brilliant though still unrestricted. Ovisacs of one of the worms were filled with a brown granular debris. The peak of reproductive activity in these worms presumably was passed at time of preservation. The breeding season presumably extends from April well into July.

Parasites. Nematodes were present in the coelomic cavities of x-xi of one worm. Large and medium-sized cysts, opaque or translucent, probably of gregarines, were numerous in coelomic cavities of the last ten to fifteen segments in several of the posterior amputees.

Remarks. The red coloration of the clitellum appears to be a formalin induced artifact as it was lacking in the single alcoholic specimen.

Nephropores of one worm were lateral to *B* on the right side of xxxiv-xxxix and in *DD* on the left side of xxxv-xxxix.

The spermathecal battery of the ancestral lumbricid presumably comprised two pairs opening to the exterior on 7/8-8/9. In the evolution of *carolinensis* two pairs, opening on 9/10-10/11 have been acquired, and all four of the original ones have been lost. As this is two more than have been eliminated in the ancestry of *lönnbergi*, in that respect *carolinensis* is more advanced.

Seminal vesicles of primitive lumbricids presumably were in four segments, ix-xii. Those of x frequently have been lost in the family but in *Eisenia* they still have not disappeared in some "formae" of a species. Presence of vesicles in x of one (or more?) of the types of *pearsei*, is about all that remains to distinguish it from *carolinensis*, and scarcely warrants specific status, if, indeed, any taxonomic recognition.

E. carolinensis and *E. lönnbergi* are the only lumbricids endemic in America that have retained spermathecae. No evidence was found in available material of either species that would indicate elimination of those organs is under way.

Table I

Typhlosole termination and segment number in *Eisenia lönnbergi*

Typhlosole ends in segment	*Atyphlosolate segments*	*Number of segments*	*Locality*	*Remarks*	
60-61*	1	62	Georgia	Amputee	
61-64*	0	64	Georgia	Amputee	
72	4	76	Virginia	Amputee	
74	4	78	Georgia	Amputee	
74	7	81		Amputee	
78	10	88		Amputee	Juvenile
81	6	87	Georgia	Amputee	
82	7	89		Amputee	
84	3	87		Amputee	
84	8	92		Amputee	
86	13	99		Amputee?	Juvenile
100	3	103		Amputee	
100	16	116			
101	13	114			
103	?	107+		Broken	
104	5	109	Georgia	Amputee	
105	8	113	Georgia	Amputee	
100-106*	10	116		Amputee	
107	5	112	Georgia	Amputee	
108	13	121			Ex copula
?	?	124			Damaged
110	14	124			
110	17	127			
111	17	128			
114	18	132			Ex copula
114	3	117		Amputee	
115	19	134			

* Typhlosole ends very gradually rather than abruptly as in other worms. Posterior ends had been broken off from worms not included above (not available), except for one juvenile, presumably of this species, which has 100 segments.

Table II

Typhlosole termination and segment number in *Eisenia carolinensis*

Typhlosole ends in segment	*Atyphlosolate segments*	*Number of segments*	*Locality*	*Remarks*
65*	6	71		Amputee
73	23	96		Juvenile. Amputee?
79	21	100		Amputee
80	19	101		Amputee
88	26	114		Amputee
82-89†	11	100	Chapel Hill	Amputee
90	32	122		Amputee
93	7	100		Amputee
97	25	122	Indian Gap	Amputee?
98	44	142	Linville	
100	37	137	Highlands	
103	32	135	Chilhowie	
105	24	129	Chilhowie	Amputee?

* Unusually low in seven preceding segments.

† Ends gradually rather than abruptly as in other worms.

Posterior ends had been broken off from the specimens not listed above at time of collection and anal pieces were unavailable.

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THREE NEW SHARK RECORDS FROM THE GULF OF MEXICO

By HENRY B. BIGELOW, W. C. SCHROEDER and STEWART SPRINGER[1]

The trawlings recently carried out by "Oregon" of the U. S. Fish and Wildlife Service in the Gulf of Mexico have yielded two specimens of *Etmopterus pusillus* (Lowe) 1839, one of *Centrophorus granulosus* (Bloch and Schneider) 1801, and one of *Dalatias licha* (Bonnaterre) 1788, sharks that had long been known in the eastern side of the Atlantic, but which had not been reported previously from the Gulf, though one specimen of *Dalatias* has been taken on the northern edge of Georges Bank.

As the Gulf of Mexico specimens of *E. pusillus* and of *C. granulosus* are the first of their kinds to be reported from the western side of the Atlantic or tributary waters, brief accounts follow to emphasize such of their diagnostic characters as may not be immediately apparent from the accompanying illustrations (Figs. 1, 2), and to justify our identifications of them.

Genus ETMOPTERUS Rafinesque 1810

Type species *Squalus spinax,* Linnaeus 1758

Whitley (1939, p. 266) has recently revived the genus *Acanthidium* Lowe 1839, type species *Centrina nigra* Lowe 1834 which, in 1839, Lowe renamed *Acanthidium pusillum,* thinking it separable generically from *Etmopterus* Rafinesque 1810, type species *Squalus spinax* Linnaeus 1758. But the differences in fin-characters cited by Whitley do not seem to us sufficient to justify this separation. And the specific name *niger* is preoccu-

[1] Contribution No. 787. Woods Hole Oceanographic Institution.

pied in *Etmopterus* by *nigrum* (Cloquet) 1820,[1] p. 93 and various subsequent authors, proposed as a substitute for *spinax* Linnaeus 1758.

ETMOPTERUS PUSILLUS (Lowe) 1839

Study material. Male, 445 mm. long, U. S. Nat. Mus. No. 157835, and female of 458 mm., Mus. Comp. Zool. No. 39572, northern part of Gulf of Mexico, "Oregon" Station 1281, Lat. 29°13′ N., Long. 87°54′ W., in 250 fathoms. Also female 278 mm. long, Madeira (Mus. Comp. Zool. No. 1026), and female of 167 mm., off Equatorial West Africa, Lat. 6°08′ S., Long. 11°24′ E., Mus. Comp. Zool. No. 38002, received through the kindness of Dr. Max Poll.

The Gulf of Mexico specimens agree so closely with those with which we have compared them, from Madeira and from tropical West Africa that we have no hesitation in referring them to the same species.

The morphological feature the most sharply diagnostic for *pusillus*, among its genus-mates of the Equatorial and North Atlantic, of the Mediterranean and of the Gulf of Mexico, is that the denticles on the sides of its trunk are low, truncate, the great majority with concave crowns, but an occasional denticle flat, or perhaps even weakly convex, on a conspicuously 4-radiate base.[2] In these respects they contrast with the slender, bristle-like denticles of *E. spinax* (Linnaeus) 1758 and of *E. schultzi* (Bigelow, Schroeder and Springer 1953, fig. 9G), with the stouter, more thorn-like denticles of *E. hillianus* Poey 1861 (Bigelow and Schroeder 1948, p. 489, fig. 92B), of *E. polli* (Bigelow, Schroeder and Springer, 1953, fig. 7 C) and of *E. princeps* (see Bigelow, Schroeder and Springer, 1953, figs. 8 E, 8 F), and with the more conical claw-like denticles of *E. virens* (Bigelow, Schroeder and Springer 1953, fig. 10 D, E).

The color, also, of *E. pusillus* is distinctive. It recalls *E. princeps*, Collett 1904, of higher latitudes in both sides of the Atlantic, and *E. schultzi* Bigelow, Schroeder and Springer 1953, of the Gulf of Mexico, in the uniformly dark slaty to black-

[1] Garman (1913, p. 223) credits the earliest use of *niger* in this connection to Gunner 1763, but we have not been in a position to verify this citation.

[2] Our earlier characterization of them as a whole (Bigelow, Schroeder and Springer 1953, p. 240) as "flat or weakly convex" was an evident misstatement.

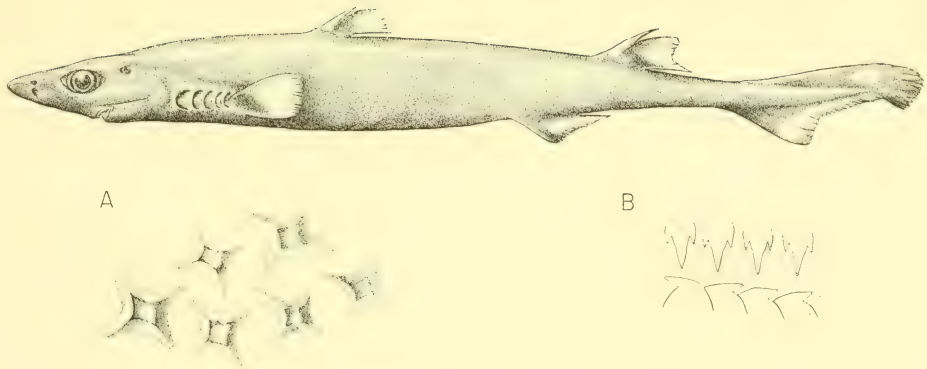

Fig. 1. *Etmopterus pusillus* (Lowe), 1839. Female, 458 mm. long, northern part of Gulf of Mexico. "Oregon" Sta. 1281, Mus. Comp. Zool. No. 39572. *A*, group of dermal denticles from below first dorsal fin, x about 40; *B*, upper and lower teeth at center of jaw, x about 5.

ish hue of its trunk not only below, but above as well (except for the pale intraocular spot mentioned below), and in the lack of definitely outlined paler and darker areas on its sides. But the outer part of its pectoral fins, with the rear part of its two dorsal fins are white and more translucent, which is not the case either in *princeps,* in *schultzi,* or in any other *Etmopterus* for that matter, that is known yet from the North Atlantic, from the Mediterranean, or from the Gulf of Mexico. This very conspicuous feature of *pusillus* is shown on Lowe's (1843, Pl. 6) original illustration of it (as *Acanthidium pusillum*) ; also on the colored illustration by Braganza (1904, Pl. 2, fig. 2, as *E. pusillus*).

Other features that in combination are diagnostic for *pusillus* are: that the upper margin of its caudal fin is only about as long as from the tip of the snout to the level of the second pair of gill openings; that the distance from the rear end of the bases of its pelvic fins to the origin of the lower side of its caudal fin is shorter than from the tip of the snout to the level of the first pair of gill openings; that the rear end of the base of its first dorsal fin is much nearer to a perpendicular at the axils of the pectoral fins than to a perpendicular at the origin of the pelvic fins; that the margins of its pectoral fins are not deeply fringed normally as they are in *E. schultzi* (Bigelow, Schroeder and Springer 1953, fig. 9 D) ; that the anterior edge of the first pair of gill openings is not concave enough to expose the tips of the gill-folds as it is in *E. princeps* (see Bigelow, Schroeder and Springer 1953, fig. 8 D) ; and that the upper surface of the head is marked between the eyes with a pale yellowish spot, as it is in *E. polli,* in *E. schultzi,* in *E. virens,* and in *E. spinax,* (where there is also a white spot "above the hind part of each orbit," Garman 1913, p. 224), but not in *E. princeps.*

Two species of *Etmopterus, schultzi* and *virens,* Bigelow, Schroeder and Springer 1953, had been known previously in the Gulf. The discovery of *pusillus* there now increases the local list to three. And a fourth member of the genus (*hillianus* Poey 1861) is to be expected there for it has been found widespread in Cuban waters and in the West Indian region, and has been recorded from as far to the northward as the offing of Chesapeake Bay.

E. pusillus, originally reported from Madeira, has since been

recorded from various localities in the eastern side of the Atlantic between Equatorial West Africa (Lat. 6°08′S, see above) and the coast of Portugal, the Cape Verde Islands, the Canaries and the Azores. Earlier reports of it from the West Indian region, listed elsewhere (Bigelow and Schroeder 1948, p. 493), seem actually to have been based on *E. hillianus*.

The discovery that *pusillus* occurs in the Gulf of Mexico shows that its range parallels that of *Centrophorus granulosus* (p. 9), also that of *C. uyato* Rafinesque 1810, which had been known only from the Mediterranean and from the eastern side of the Atlantic in low and mid-latitudes until 1951-1952, when "Oregon" trawled 2 specimens of it in the Gulf (Bigelow, Schroeder and Springer, 1953, p. 227).

Tanaka (1912, pl. 22; p. 88) also, has referred to *pusillus* the Japanese shark that was earlier described and pictured by Pietschmann (1907, p. 395; 1908, p. 654, pl. 1, fig. 2, pl. 2, fig. 2) as *E. frontimaculatus*. But while the latter agrees with *pusillus* in the nature of its dermal denticles (Pietschmann, 1908, p. 657, text figs. 1, 2), it differs from *pusillus* in a more rearward position of the first dorsal fin (relative to the positions of the pectoral and pelvic fins), in a relatively longer interspace between the pelvic and caudal fins, and in color pattern, with the lower surface of its head, its belly, and a definitely outlined area above and anterior to each pelvic fin much darker than the upper part of its sides. A further difference is that the lower surface is as densely clothed with denticles as are the sides and back in *pusillus* whereas it is largely naked in the Japanese species.

Genus CENTROPHORUS Müller and Henle 1837

Type species *Squalus granulosus* Bloch and Schneider 1801

CENTROPHORUS GRANULOSUS (Bloch and Schneider) 1801

Study material. Female 922 mm. long from northern part of Gulf of Mexico, Lat. 29°15′N., Long. 88°18′W., "Oregon" Sta. 1246, 200-210 fathoms, U. S. Nat. Mus. No. 157833; also skin of a male, 855 mm. long, eastern Atlantic, exact locality not known, Mus. Comp. Zool. No. 662.

Fig. 2. *Centrophorus granulosus* (Bloch and Schneider), 1801. Female, 922 mm. long, northern part of Gulf of Mexico. "Oregon" Sta. 1246, U. S. Nat. Mus., No. 157833. *A*, lower surface of anterior part of head; *B*, upper and lower tooth band, left hand side of jaw, x about 1.7; *C*, cutting edge of 5th lower right hand tooth, x about 7, to show serrations; *D*, dermal denticles from side below first dorsal fin, x about 11.

The most evident diagnostic features that set apart *C. granulosus* (with *C. machiquensis* Maul 1955) from the other two species of its genus (*squamosus* Bonnaterre 1788 and *uyato* Rafinesque 1810) that are known from the North Atlantic province are: that the inner corner of its pectoral fins is greatly extended and narrowly pointed (Fig. 2); that the interspace between its two dorsal fins is longer than the head (to origin of pectoral fins) by a distance nearly as long as the eye; that the denticles on the sides of the body are low, block-like with the ridges on the outer surface converging rearward, closely spaced in quincuncial arrangement, but not overlapping (Fig. 2, *D*); and that the upper teeth are erect and nearly symmetrical all along the central part of the jaw (Fig. 2, B). In *granulosus* also, as in *squamosus,* the cutting edge of the lower teeth is partially serrate, but so finely so that this feature is visible only on careful examination under a lens (Fig. 2, *C*). In *uyato,* on the contrary, the lower teeth are smooth-edged, like the uppers.

Proportional dimensions, in per cent of total length, of female, 922 mm. long, northern part of Gulf of Mexico, U. S. Nat. Mus. No. 157833.

Trunk at origin of pectoral. Breadth 9.7, height 10.8.
Snout length in front of. Outer nostrils 2.8; mouth 9.1; eye 4.9
Eye. Horizontal diameter 4.9.
Mouth. Breadth 7.9.
Nostrils. Distance between inner ends 3.6.
Spiracles. Distance between inner ends 7.0.
Labial furrows, upper. Length 5.4; distance between inner ends 6.4.
Gill openings, lengths. 1st 2.6; 2nd 2.7; 3rd 2.8; 4th 3.0; 5th 3.3.
First dorsal fin. Vertical height 5.4; length of base 11.1; base rearward from anterior beginning of spine 8.5; diagonal from emergence of spine to rear end of base 7.1; free rear margin of fin 6.9.
Second dorsal fin. Vertical height 5.0; length of base 7.0; base rearward from anterior beginning of spine 5.7; diagonal from emergence of spine to rear end of base 5.4; free rear margin of fin 4.5.
Caudal fin. Upper margin 20.3; lower anterior margin 12.3.
Pectoral fin. Outer margin 12.9; inner margin 13.2; greatest width 7.6.

Distance from snout to. 1st gill opening 16.8; to origin of 1st dorsal spine 34.8; to origin of 2nd dorsal spine 69.2; upper caudal 79.7; pectoral 22.2; pelvics 58.7.

Interspace between. Anterior beginning 1st dorsal spine to 2nd dorsal spine 34.4; rear tip of 1st dorsal fin to rear tip of 2nd dorsal 29.5; 2nd dorsal and caudal 6.0; pelvics and caudal 13.4.

Distance from origin to origin of. Pectoral and pelvics 37.6; pelvics and caudal 18.1.

Head, to origin of pectoral fins, about 28 per cent of trunk to origin of upper side of caudal fin; snout moderately rounded, its length in front of snout about ⅓ of head to origin of pectorals; eye about 22 per cent as long as head; distance from level of front of eyes to tip of snout about as long as eye; spiracle about ¼ as long as eye, its anterior edge only slightly posterior to rear corner of eye. Nostrils a little less than ½ as long as distance between nostrils, approximately transverse, the outer ends posterior to level of tip of snout by a distance a little shorter than distance between nostrils. Anterior nasal flap short, narrowly triangular. Distance between nostrils a little less than ½ as great as from tip of snout to mouth. Mouth very low-arched, its gape when closed occupying about ⅕ of breadth of head at level of outer corners of mouth. Distance between inner ends of nasal furrows about 1.8 times as long as between nostrils. Longest gill opening (5th) is almost as long as distance between nostrils.

Teeth $\frac{40}{15\text{-}1\text{-}15}$, of shapes illustrated in Figure 2, *B;* uppers with the post-functional (outermost) row partly lost, followed by a nearly vertical functional row and then by an oblique backward pointing row that will be next in service; lowers with two rows visible from outside the mouth, one of which is functional, 16 teeth pointing to the right hand side, of which one is a median tooth, and 15 teeth pointing to the left hand side; cutting edge of some of the lowers with microscopically fine and somewhat irregular serrations (Fig. 2, *C*) but others merely somewhat irregular, a difference probably due to wear. Dermal denticles on sides of body sessile, block-like, sub-quadrate, with the more acute corner directed rearward, closely spaced in quincuncial pattern but not overlapping, the crown weakly convex or flat, its anterior ½ to ⅔ with (usually) 5-7 low ridges, converging rearward (Fig. 2, *D*), the outermost pair the longest.

Denticles at mid-level of side below first dorsal fin averaging about 0.9 mm. long.

Length of base of first dorsal fin, measured from point of emergence from skin of anterior side of first dorsal spine, about 1.3 times as long as base of second dorsal fin, similarly measured. Interspace between rear end of base of first dorsal and point of emergence of second dorsal spine longer than head (to origin of pectorals) by a distance about equal to length of eye and about 7½ times as long as between nostrils. Exposed portion of first dorsal spine about 1⅓ times as long as that of second spine, the second spine reaching about mid-way along the free anterior margin of the fin. Interspace between rear end of base of second dorsal fin and origin of upper side of caudal fin about as long as base of second dorsal fin measured from point of emergence, from skin, of anterior edge of second dorsal spine.

Upper edge of caudal fin about as long as from tip of snout to level of fourth pair of gill openings, its lower edge with obtuse subterminal notch and rounded lower anterior lobe. Interspace between origin of lower edge of caudal fin and rear ends of bases of pelvic fins about ⅗ as long as from tip of snout to level of 5th pair of gill openings. Origin of pelvic fins (in female) anterior to a perpendicular at emergence of anterior edge of second dorsal spine, by an amount about equal to interspace between origin of lower edge of caudal fin and rear ends of bases of pelvic fins. Pectorals with inner corner greatly extended and narrowly pointed, reaching rearward (when laid back) nearly to a perpendicular from rear base of first dorsal fin.

Sharks referable with certainty to *granulosus*, not to *uyato* which Rey (1928, p. 436) considered synonymous with it, had previously been recorded in the Mediterranean, off the coast of Portugal, and at Madeira (specimen in British Museum; Günther 1870, p. 421). The capture of a typical *granulosus* in the Gulf now shows that its Atlantic range parallels that of *C. uyato* Rafinesque 1810, which was recently found to occur in the Gulf (Bigelow, Schroeder and Springer 1953, p. 227). The third species of *Centrophorus* that is known from the Atlantic (*squamosus* Bonnaterre 1788) has so far been reported only off the coast of Portugal and northward to southwestern Iceland and the vicinity of the Faroes.

Pietschmann (1908, pp. 663-667) credits *granulosus* to Japan also, from his comparison of two Japanese specimens with *granulosus* from the Mediterranean. But the eventual decision, whether the northwestern Pacific *Centrophorus* of this general character is indeed indistinguishable from the Atlantic-Mediterranean *granulosus,* is best postponed until a larger number of specimens have been examined, critically, with this question in mind.

Genus DALATIAS Rafinesque 1810

DALATIAS LICHA (Bonnaterre) 1788

Study material. Female 845 mm. long from northern part of Gulf of Mexico, Lat. 28°25′N., Long. 86°02′W., "Oregon" Sta. 1275, 225 fathoms, U. S. Nat. Mus. No. 157834.

The specific identification of this specimen as *D. licha* is so evident, from its close agreement in bodily form, fin characters, teeth, and denticles with the Georges Bank specimen described and pictured previously (Bigelow and Schroeder 1948, p. 502, figs. 96, 97) that no further account seems called for here.

As the only previous record for this shark in the western Atlantic was this Georges Bank example, the capture of one in the northern part of the Gulf of Mexico widely expands its known range.

In the eastern side of the mid and north Atlantic the known range of *D. licha* extends from Equatorial West Africa (Rio de Oro) to the Irish Atlantic slope, including the Mediterranean. And it is doubtful whether the representatives of the genus that have been reported from South Africa, from the New Zealand-Australian region and from Japan can be separated specifically from *D. licha* of the Atlantic. (For discussion, see Bigelow and Schroeder 1948, p. 501).

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BREVIORA

Museum of Comparative Zoology

CAMBRIDGE, MASS. NOVEMBER 30, 1955 NUMBER 50

NEW FROGS OF THE GENERA *ASTEROPHRYS* AND *OREOPHRYNE* FROM NEW GUINEA

By ARTHUR LOVERIDGE

During the past year the Museum of Comparative Zoology has received from Mr. Kenneth R. Slater some interesting microhylids including *Asterophrys rufescens* (Macleay), *valvifera* (Barbour), *turpicola* (Müller); *Xenobatrachus rostratus* (Méhely); *Metopostira ocellata* Méhely and *Cophixalus oxyrhinus* (Boulenger), taken at Omati, near Port Moresby, Papua.

There was also a large and handsome frog which keyed down to *Asterophrys boettgeri* (Méhely) in the synopsis to that genus furnished by H. W. Parker in his "Monograph of the Microhylidae" (1934:60. Brit. Mus.). However, *A. boettgeri* comes from Halmahera Island in the Moluccas lying to the northwest of Dutch New Guinea, while Omati is situated in the southeast of New Guinea. After Dr. E. E. Williams and I had re-examined the Omati specimen and come to the conclusion that it was probably new, it was submitted to Dr. Parker for favor of his confirmation. Meanwhile, in the hope that the collector might be able to secure more material, publication has been deferred for nearly a year. Mr. Kenneth Slater, after whom I take pleasure in naming it, now informs me that there is little hope of his obtaining a series for he will soon be returning to Australia.

ASTEROPHRYS SLATERI sp. nov.

Holotype. Museum of Comparative Zoology No. 28205, an adult ♀, from Omati, near Port Moresby, Papua. Collected by Kenneth R. Slater between January and April, 1954.

Diagnosis. Apparently closely related to *A. boettgeri* (Méhely) from which it differs in having a much longer (*not* shorter) snout;

an interorbital space that is one and one-third times as broad as (instead of equal to) an upper eyelid; tibio-tarsal articulation of adpressed hind limb reaching eye (instead of nostril); some details of coloration; and size, being 52 mm. (instead of 39 mm.; a difference that may be sexual). Possibly it is only racially distinct.

Description. Anterior palatal ridge curved, smooth. Snout subacuminate, longer than the horizontal diameter of the eye, which is equal to the distance from nostril to orbit; canthus rostralis rounded; interorbital space one and a third times as broad as an upper eyelid; tympanum moderately distinct, its horizontal diameter about half that of the eye; fingers long, the first much shorter than the second, which is slightly shorter than the fourth, the third being much the longest, all terminating in large subtriangular disks which are larger than those of the toes; both fingers and toes free of web; inner metatarsal tubercle indistinct; tibio-tarsal articulation of the adpressed hind limb reaches the eye.

Skin of head, except on occiput, pustular, especially noticeable on upper eyelids; some glandular folds on the occiput, scapular region and dorsum, the latter also displaying a few scattered tubercles; forelimb, more particularly the upper arm, studded with tubercles. Below, smooth.

Color. Above, purplish brown spotted with black and flecked with white (on body tubercles); on the occiput and back are four or five, more or less W-shaped, white lines corresponding to the glandular folds; posteriorly an obsolete, hair-like, light vertebral line is barely distinguishable; thighs heavily blotched with black, the elongate blotches separated by irregular white lines; on the tibia these light lines suggest obsolete crossbars.

Below, pale brownish spotted with darker brown and variegated with indistinct white vermiculations; these coalesce to form indistinct crossbars on the underside of the forelimbs, larger, broader, and pure white on the hind limbs; lower jaw with two downward-pointing, white, triangular spots on either side of the symphysis, while a less conspicuous pair is situated near the angle of the jaw.

Size. Holotype ♀. Length of head (from end of snout to back of tympanum), 18 mm.; length from snout to anus, 52 mm.; length of hind limb (from anus to tip of longest toe), 80 mm.

Diet. The stomach and intestinal contents, examined by my colleague Dr. W. L. Brown, were so finely masticated as to be undeterminable except for some fragments of small shells, the leg of an ant, and the chitinous plates of some arthropod.

Parasites. The stomach wall and other organs carried numerous encysted nematodes; one threadworm (preserved) was free in the body cavity.

Oreophryne parkeri sp. nov.

Cophixalus geislerorum Loveridge (not of Boettger), 1948, Bull. Mus. Comp. Zool., **101**: 423.

Holotype. Museum of Comparative Zoology No. 12964, an adult ♀, taken from running water in sago-palm forest at Matapan, Australian New Guinea. Collected by E. A. Briggs about January, 1923.

Paratype. British Museum No. 1955.1.1.17, with same data as type.

Diagnosis. In Parker's synopsis to the genus (1934:160) these frogs key down to the *anthonyi-biroi* section but are not very closely related to either species. *Oreophryne anthonyi* (Boulenger), of which we have a cotype, is a more robust frog than the gravid holotype of *parkeri*, from which it differs slightly in almost every character, the most conspicuous being the coloring of the underside and:

Eye separated from tympanum by a distance equal to 1½ times the horizontal diameter of the latter. Total length of adult 45 mm. . . . . *anthonyi*
Eye separated from tympanum by a distance equal to only ⅓ the horizontal diameter of the latter. Total length of gravid ♀ 30 mm. . . . . *parkeri*

O. parkeri agrees with *biroi*, of which we have a series, in size and many other respects, but differs sharply in tympanic characters.

Tympanum scarcely distinct, very small, ¼ to ⅓ the eye diameter; disk of third digit nearly ½ the eye diameter; ratio of tibia length to head width at commissure of mouth 1.1 to 1.3 (4 ex.) . . . . . *biroi*
Tympanum very distinct, large, ⅔ the eye diameter; disk of third digit nearly ⅔ the eye diameter; ratio of tibia length to head width at commissure of mouth 1.37 to 1.43 (2 ex.) . . . . . *parkeri*

The head of *parkeri*, as Dr. R. G. Zweifel has pointed out to me, is relatively small compared with those of other *Oreophryne*.

Description. Palate with a row of three transversely elongate tubercles followed by a denticulated dermal ridge in front of pharynx. Snout truncate, subequal to the horizontal diameter of the eye, which is about equal to seven-eighths its distance from the nostril; canthus rostralis rounded; loreal region slightly oblique, distinctly concave; interorbital space more than one and a half times as broad as an upper eyelid; tympanum very distinct, almost two-thirds the diameter of the eye to which it is very close; fingers long, the first much shorter than the second, which is subequal to the fourth, the third being much the longest, its disk almost two-thirds the diameter of the eye, all fingers terminating in large subtriangular disks which are somewhat larger than those of the toes; toes webbed at the base, the third slightly shorter than the fifth, inner metatarsal tubercle very indistinct, outer absent; tibio-tarsal articulation of the adpressed hind limb reaches the shoulder.

Skin of head smooth, except for a slightly raised median line and the suggestion of a supratympanic fold; between the shoulders a)(-shaped glandular fold. Belly smooth (? preservation).

Color. Above, brown, uniform except for some dark crossbars on the limbs and light areas in groin. Below, brown, paling posteriorly towards groin; thighs flecked with white, tibiae largely white.

Size. Holotype ♀. Length of head (from end of snout to back of tympanum), 7 mm.; length from snout to anus (which was 28 mm. prior to dissection), now 30 mm.; length of hind limb (from anus to tip of longest toe), 37 mm.

Diet. The stomach of the holotype contained the remains of scores of a shiny black *Iridomyrmex* ant (smaller than either *batesi* or *scrutator*), a group that is known to forage in trees; also a single head of one of the arboreal *Podomyrma* ants.

Remarks. In 1948, when reporting on the "New Guinean Reptiles and Amphibians in the Museum of Comparative Zoology" (Bull. Mus. Comp. Zool., **101**: 303-430), I erroneously referred these two frogs to *Cophixalus geislerorum* Boettger. More recently, when Dr. R. G. Zweifel of the American Museum of Natural History was working over our material, he redetermined them as *Oreophryne* of no known species. I then submitted them to Dr. H. W. Parker who replied that a clavicle is present though not reaching the scapula, so that they are unquestionably *Oreophryne*,

also eleutherognathine.

I am also indebted to Dr. Parker, after whom this new species is named, for supplying me with the ratios of tibial length to head width at commissure which, in the cotypes of *O. anthonyi* is 1.14 to 1.38, with an average of 1.25. Parker also observes that, according to Boettger, Nieden and Vogt, *C. geislerorum* is without a tympanum; the contrary view was stated by van Kampen and so got included in the monograph.

BREVIORA

Museum of Comparative Zoology

CAMBRIDGE, MASS. January 27, 1956 NUMBER 51

A SMALL MUSTELID FROM THE THOMAS FARM MIOCENE

By STANLEY J. OLSEN

INTRODUCTION

For the past ten years the Museum of Comparative Zoology has conducted field work at the Thomas Farm (Florida) for at least one season each year. During the latter part of this decade an intensive search has been made with the view of increasing our knowledge of the microfauna of this unique Miocene deposit. Although minute vertebrate fossils have been collected from every part of the excavation, by far the most productive area has been the boulder bar described by Dr. T. E. White in 1942. The material — mammal, bird and reptile — occurs here in the matrix between the boulders of Ocala limestone comprising the bar, and the latter have served to prevent the crushing and breakage elsewhere characteristic of the quarry.

Three large mustelids have been described from this area by White: *Mephititaxus ancipidens* 1941, *Aelurocyon spissidens* 1947 and *Oligobunis floridanus* 1947. The isolated upper molars referred to by White in 1942 (M.C.Z. Nos. 3639, 3640) as mustelids, have been re-identified as deciduous teeth of a canid. The lower jaws, without teeth, mentioned by him (M.C.Z. Nos. 7029, 7030) are conspecific with the specimen here described.

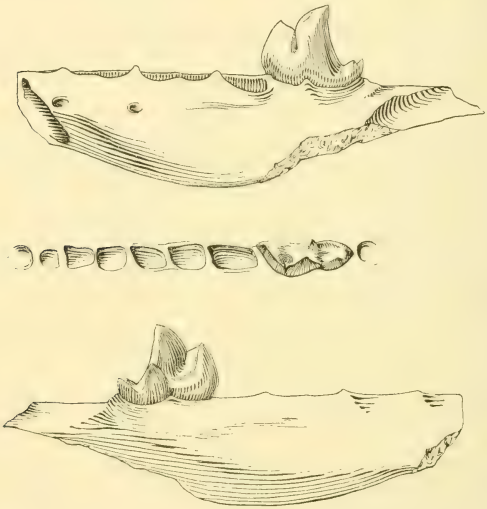
This individual, although incomplete, marks the first occurrence of associated mandible and tooth in a small mustelid from this locality.

Family MUSTELIDAE
Subfamily MUSTELINAE

MIOMUSTELA(?) sp.

Referred material. M.C.Z. No. 7016 (Fig. 1), incomplete left mandible with M_1 present and alveoli for C, P_1, P_2, P_3, and M_2 (incomplete).

Horizon and locality. Arikareean Miocene. Thomas Farm, Gilchrist County, Florida.



Miomustela(?) sp. Labial, occlusal and lingual views. M.C.Z. 7016. X 3.

Characters. Closest to *Miomustela madisonae* (Douglass 1903; Hall 1930) among previously known forms but differing as follows: M_1 with metaconid smaller, all other crown elements 25 per cent larger.

Description. The mandible is short and shallow and the number of premolars is reduced to three. All of the premolars are

double rooted and their arrangement indicates a crowded tooth row. M_1 has a large well-defined protoconid with a pronounced cleft between the protoconid and paraconid. The metaconid is about one-half the size of the paraconid. The talonid is basined, with a well-defined rim and the hypoconid retains its individuality. The hypoconulid is small but distinct. The paraconid-protoconid shear is nearly parallel with the long axis, making the protoconid-metaconid width narrow as compared with the tooth length. M_2 is single rooted. The ascending ramus of the jaw starts just posterior to M_1, causing M_2 to be tilted upward and forward. The masseteric fossa extends forward to the anterior rim of the alveolus of M_2. Mental foramina are present below the centers of P_1 and P_2.

MEASUREMENTS (IN MILLIMETERS) OF MANDIBLE & TOOTH	
LENGTH OF TOOTH ROW AS INDICATED BY ALVEOLI (ANTERIOR MARGIN OF P_1 TO POSTERIOR MARGIN OF M_1)	18.0
DEPTH OF MANDIBLE BELOW M_1	5.7
M_1, GREATEST ANTEROPOSTERIOR DIAMETER	6.0
M_1, GREATEST TRANSVERSE DIAMETER	2.5
M_1, HEIGHT OF PROTOCONID FROM LABIAL MARGIN OF ALVEOLUS	5.0
M_1, " " METACONID " LINGUAL " " "	2.5
M_1, " " PARACONID " " " " "	3.5
M_1, " " HYPOCONULID " " " " "	1.7

DISCUSSION

Plesictis (including *Mustelavus*) agrees with M.C.Z. No. 7016 in the general structure of M_1, but *Plesictis* has the metaconid and paraconid of equal size, and a jaw that is longer (with four premolars) and lighter in build, the ascending ramus arising well behind M_2 (Teilhard de Chardin 1914; Viret 1929; Clark 1937; Simpson 1946; Hall 1951; and original material).

Agreement of our specimen with *Miomustela* is closer than with *Plesictis* — sufficient at least to justify tentative generic assignment. Minor differences between the type of *Miomustela* and M.C.Z. No. 7016 are an apparently lower paraconid and talonid

in the type. I believe that these are due to the unworn condition of the described specimen, compared with the worn cusps of the type. This is based on study of the amount of wear undergone by M_1 in a large series of *Martes americana*, the essentially similar cusp arrangement shared by this genus and *Miomustela* permitting a valid comparison. This series shows that such differences may indeed be due to wear.

The species represented by this fragment is clearly distinct from *M. madisonae* but, considering the fragmentary nature of available specimens, I refrain from proposing a new species. Further material may, in fact, show that a new generic assignment is necessary.

Acknowledgments. I am indebted to Professor A. S. Romer for the use of the material and to Professor Bryan Patterson for his helpful criticism. Also to Dr. J. LeRoy Kay for the loan of the type of *Miomustela*. The figure was drawn by Miss Patricia Washer.

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BREVIORA

Museum of Comparative Zoology

CAMBRIDGE, MASS. April 6, 1956 NUMBER 52

REMARKS ON SOME MIOCENE ANURANS FROM FLORIDA, WITH A DESCRIPTION OF A NEW SPECIES OF *HYLA*

By WALTER AUFFENBERG

Up to now, the only reference to Miocene anurans from Florida is by Tihen (1951), who described a new species of *Bufo* and allocated other remains to *Rana* sp. All of these fossils were collected at Thomas Farm, Gilchrist County, Florida. While washing a considerable amount of matrix from this same deposit in search of fossil snakes, a rather large number of amphibian remains were found, and these form the basis of this report. The new material permits addition of three more genera to the fauna of the Miocene, and also contributes to a better understanding of the relationships of the previously described *Bufo*.

BUFO PRAEVIUS Tihen

This toad was described on the basis of fragmentary elements of both the axial and appendicular skeletons. The relationships of *B. praevius* were not discussed at length by Tihen, although he stated that the ilium is somewhat comparable to that in *B. terrestris* and *B. valliceps*. Considerable additional material from the same deposit contributes to our knowledge of its probable relationships. Of particular interest is the fact that there are now available cranial elements, generally considered to be quite diagnostic between species of toads. This is especially true of the orientation and degree of development of the various cranial crests. Information regarding these structures is now available for *praevius*.

The systematic relationships of many of our North American toads have been the subject of considerable controversy during

the last few years. The present paper does not deal with the status of the species or subspecies of Recent *Bufo,* and the latest checklist (Schmidt, 1953) has been followed throughout for taxonomy.

As comparative material, a number of Recent toads have been skeletonized and examined: *Bufo t. terrestris* (23), *B. t. americanus* (1), *B. w. woodhousei* (2), *B. w. fowleri* (3), *B. valliceps* (2), *B. punctatus* (1), *B. compactilus* (1), *B. simus* (1), *B. granulosus* (1), *B. quercicus* (4), *B. perplexus* (1) and *B. pelticephalus* (1).

The ilium is considered by many workers as being of considerable value in distinguishing many genera of fossil anurans, and is the element on which the description of *B. praevius* rests. Sixty-two additional ilia of *praevius* have been collected at the type locality; these have been deposited in either the collections of the University of Florida (UF), or those of the Museum of Comparative Zoology (MCZ).

One of the most important characters of the ilium is the shape and degree of development of the dorsal prominence. In *praevius* this prominence is fairly low, similar to the same structure in *B. terrestris, valliceps* and *woodhousei.* On the other hand, *B. compactilis* and *cognatus* (latter *fide* Tihen, *op. cit.*) have a spine-like prominence, being high, with a narrow base. This fact apparently indicates a closer relationship between *praevius* and the *terrestris* group than with *compactilis* and/or *cognatus.* In *B. simus, punctatus, pelticephalus, quercicus, perplexus* and *granulosus* the prominence is not roughened or knob-like, but forms a smooth, well-defined, rather sharp dorsal edge.

Though the ilial prominence appears, in general, to be useful in separating natural species groups in the genus *Bufo,* changes in shape and proportions with growth are complicating factors that must be recognized. In an examination of the shape of the prominence in a series of ilia of *Bufo praevius* now available, it is obvious that this character is more variable than indicated in Tihen's original series. As in modern *B. terrestris,* this structure may vary from very low and smooth in small specimens, to considerably higher and roughened in larger individuals.

Tihen stated that the ilial shaft of *praevius* seemed to be less compressed than in other toads with which he compared it; but he also indicated that the degree of compression was not beyond

the range of variation found in the living forms. The diagnostic importance of this character is considerably lessened by the fact that a comparison of the degree of compression in the larger series of ilia of *praevius* now available and a series of ilia of modern *terrestris* shows little, if any, difference between the two species.

Another character of apparent diagnostic importance is the curvature of the ilial shaft, which according to Tihen is less than that in other species of *Bufo* which he had examined, though not beyond the range of variation of modern species. This character, as well as many others, shows considerable ontogenetic change. However, the present series tends to confirm Tihen's observation, i.e., that the ilial shaft in *praevius* is, for the most part, less curved than in most other species.

In none of the ilia is there a process on the antero-ventral edge of the acetabular expansion such as Tihen observed in one specimen (MCZ 1933). He states that although the ilium may be aberrant, it might also represent still another species of *Bufo*. A similar element has not turned up and it is highly probable that this specimen is an aberrant one.

Three fragmental urostyles were also available to Tihen, who stated that the crest was probably lower in *praevius* than in most modern species. Although a number of fragmental urostyles have been collected, only two elements have been found complete. In these, as well as in the urostyles of two specimens of Recent *valliceps*, the height of the crest is equal to, or slightly less than the width of the articular surfaces. This crest is practically always higher than the greatest width of the anterior articular surfaces in Recent specimens of *B. t. terrestris, t. americanus, w. woodhousei* and *w. fowleri*.

A considerable number of presacral vertebrae are available for the fossil species. They do not appear to be "heavier" than those of modern species, but are seemingly identical with those of *B. terrestris* and *B. woodhousei*. A number of sacral vertebrae are also available. One sacral was found to be fused to the preceding element, forming a very symmetrical unit. This unit is clearly referrable to a bufonid, most likely representing an aberrant specimen of *Bufo praevius*.

Of particular interest in the diagnosis of modern species of toads is the shape of the cranial crests. Fortunately, cranial ele-

ments of the fossil species are now available. These include three frontoparietals (UF 9892), two temporals (UF 9893), three bones of the occipital complex and a number of squamosal stems and mandibles (UF 9894). Thus it is possible to reconstruct the major cranial ridges of the fossil form. In the following discussion the terminology used by Sanders (1953) is used throughout, since the system seems reasonable and practical.

The available frontoparietals of the fossil species are somewhat fragmentary, but indicate a number of important facts. They are cancellous and provided with well-developed crests. Furthermore, the shape and development of these crests clearly show that its relationships lie with the *terrestris-woodhousei* species complex. From above, the parietal ridges of *praevius* are slightly diverging posteriorly. The fragmentary elements are not large enough to determine the length and size of the frontal ridges, although such ridges probably existed, as based on an examination of the anterior ends of the fragments. The parietal ridges are low anteriorly, gradually increasing in height posteriorly, much in the manner of those of *woodhousei*. From above, these ridges are relatively narrower than in *terrestris* or *houstonensis* (the latter *fide* Sanders, *op. cit.*, fig. 2), but like those in *woodhousei*. From the side they are slightly arched, as in *valliceps*, not straight as in *woodhousei, terrestris* or *houstonensis*. The otoparietal ridge is well-developed and rounded, being somewhat intermediate between that in *houstonensis* and *w. fowleri*. It is not as high and narrow as in *valliceps*. It is better developed than in *terrestris*, and of a different shape. The angle formed between the otoparietal and parietal ridges is approximately 90°, not greater, as in *valliceps*. The occipital groove, if present, is very inconspicuous. The otoparietal plate is not much wider than its ridge, as in *houstonensis*. However, it should be pointed out that this character, given considerable weight by Sanders (*op. cit.*), varies with age and possibly with locality in at least *B. terrestris*. The largest part of the temporal plate is cancellous, provided with a well-developed, but rounded temporal ridge. The tympanic and supratympanic ridges are definitely well developed, but to an unknown degree due to the fragmentary nature of the available elements. The parietal spur is well developed, directed backward and medially. It is not club-like as in *t. americanus*, but is similar to that in *B. woodhousei*. The shape

and position of the cranial crests in *B. praevius* and three closely related modern species are shown in Figure 1.

From the foregoing description of additional remains of *Bufo praevius* it is highly possible that its relationships lie with the eastern toads. This has been intimated by Tihen in regard to the ilial prominence, and is very much strengthened by the shape and

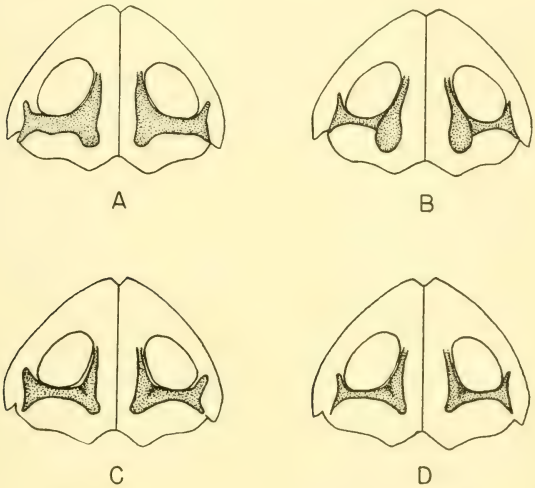

Fig. 1. Shape of the cranial crests in four species of *Bufo*. *A, Bufo houstonensis* (after Sanders, *op. cit.*); *B, Bufo t. terrestris; C, Bufo praevius; D, Bufo w. fowleri.*

development of the cranial ridges. A few of the characters, such as the height of the urostyle crest and the arching of the parietal ridge are somewhat suggestive of *B. valliceps.* The importance of the suggested close relationship of *praevius* to the *terrestris-woodhousei-houstonensis* complex is that it indicates that this group was already well established by early Miocene.

Rana sp.

This genus has already been reported from the Thomas Farm by Tihen (*op. cit.*). Two additional ilia are now available (UF 5919). These remains are too fragmentary to make a species identification possible, although the shape of the posterior edge of the dorsal crest is highly suggestive of the *pipiens* "group", including *palustris, pipiens, sylvatica, clamitans,* etc. They are not as readily referrable to the group including *heckscheri, catesbeiana* and *grylio.*

Scaphiopus cf. holbrooki

In the fossil record, *Scaphiopus* is known from Pliocene (Taylor, 1941) and Pleistocene (Tihen, 1954) deposits of North America. Its occurrence in the early Miocene of Florida is thus of considerable interest.

The genus is frequently divided into two subgenera: *Scaphiopus* (including *h. holbrooki, h. hurteri* and *couchi*) and *Spea* (including *multiplicatus, bombifrons* and *hammondi*). Skeletons of all species except *multiplicatus* have been examined.

Included in the fossil material from Thomas Farm are four fragmentary ilia (UF 9896), one maxilla (UF 9897), three fragmentary frontoparietals (UF 9898) and one presacral vertebra (UF 9899), all of which appear to belong to this genus.

The ilium of the subgenus *Scaphiopus* is quite diagnostic. There is no ilial crest, and the dorsal prominence is absent or but slightly developed. When present it may exist as a small, rounded protuberance, directed dorso-laterally, about half way between the base and the end of the acetabular expansion. In the subgenus *Spea* the prominence is usually ridge-like, directed more dorsally, and contributing to the height and length of the dorsal portion of the acetabular expansion. In the fossil ilia the dorsal prominences are very small and rounded, identical with those found in the subgenus *Scaphiopus.* The disposition of the maxillary teeth, as well as the shape of the entire element, are also comparable to those of the subgenus *Scaphiopus.* There is no frontoparietal boss, such as is present in some members of the genus. On the basis of the available fossil remains, the Miocene form is not distinguishable from the modern species, *Scaphiopus holbrooki.*

Whether or not the Miocene *Scaphiopus* was identical to the species *holbrooki* cannot be absolutely determined at this time. However, the fossil form is clearly referrable to the subgenus *Scaphiopus*. Whether or not the subgenus *Spea* had differentiated by this time, or whether the former is ancestral to the latter is, of course, unknown. Further collecting in other Tertiary deposits of middle North America may clarify many of our concepts regarding the ancestry of this group.

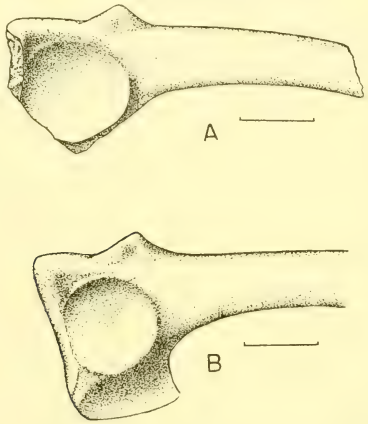

Fig. 2. Comparison of the fossil microhylid ilium from the Thomas Farm locality (*A*) with that of a recent specimen of *Microhyla carolinensis* (*B*), from Gainesville, Florida. The line represents 1 mm.

Microhyla sp.

Of considerable interest is the fact that one fragmental ilium from the Thomas Farm (UF 5144) apparently represents the genus *Microhyla*. Its very small size and well-developed dorsal prominence (which is triangular from the side and without any protuberances or roughened areas of any kind) are highly suggestive of this genus. In addition, the acetabular cup is very similar to that in *Microhyla*, in that the edges of the cavity are considerably raised above the surface of the acetabular expan-

sion. Although broken, the ventral portion of the acetabular expansion was apparently narrow and directed downward as in this genus. That this element does not represent a young specimen of *Bufo* is indicated in the shape of the dorsal prominence. In small specimens of *Bufo* this prominence is weakly developed, being low and long, usually with a roughened area on, or very near the dorsal edge. The genus *Microhyla* has not been reported as a fossil. Additional material, both fossil and modern, is necessary before specific identification of the fossil form will be possible (see Fig. 2).

In addition to the remains already mentioned, three ilia were found which are referrable to either *Hyla*, *Pseudacris* or *Acris*. They are placed in the genus *Hyla* mainly for reasons of convenience. Neither *Acris* nor *Pseudacris* have been found as fossils. *Hyla* has been reported from the Pleistocene of North America (Brattstrom, 1953). The fossils under consideration appear to represent a new species. I wish to name this form for Dr. Coleman Goin, who has contributed materially to our knowledge of modern amphibians in life history studies, ecology and taxonomy.

Hyla goini nov. sp.

Diagnosis. A Miocene *Hyla* with a relatively high ilial shaft; ilium without a dorsal crest; ilial prominence rounded, well developed, with the protuberance located rather low on the prominence, projected dorsally and laterally, its anterior edge practically even with, or slightly behind the anterior edge of the acetabulum; ventral portion of the acetabular expansion broad at its base; acetabulum somewhat sub-triangular.

Holotype. MCZ 2277; the distal 7 mm. of a right ilium, collected by Walter Auffenberg, March, 1954 (Figure 3).

Horizon and Type Locality. Hawthorne formation, Lower Miocene, Arikareean; Boulder Bar, Thomas Farm, Gilchrist County, Florida.

Referred Material. UF 9900; three fragmental ilia from the same locality and horizon.

The ilia of the genera *Hyla*, *Acris* and *Pseudacris* are easily separated from those of *Rana* and *Eleutherodactylus* by the absence of a dorsal crest. From *Microhyla*, *Bufo* and *Scaphiopus* they are readily distinguished by the well-developed dorsal prom-

inence, directed dorsolaterally to laterally, and by the slenderness of the shaft itself.

The ilia of *Hyla goini* have been compared with the same element in the following genera and species: *Hyla cinerea* (12), *H. squirella* (6), *H. femoralis* (2), *H. crucifer* (2), *H. versicolor*

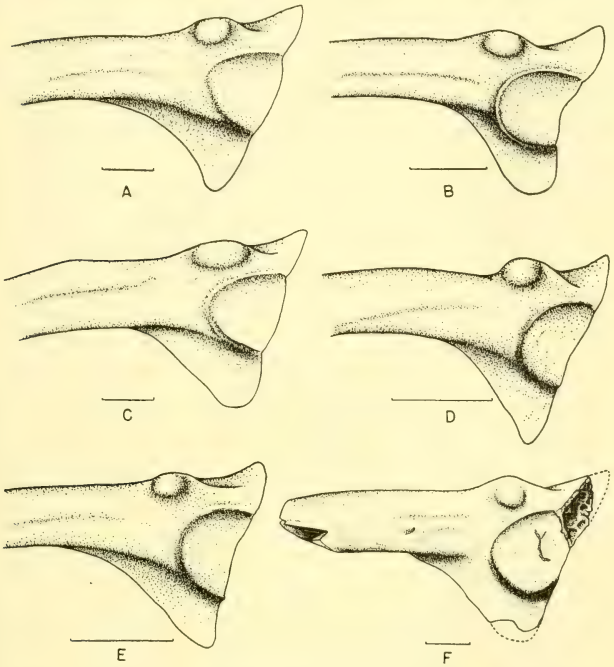

Fig. 3. Interspecific variation in the ilia of Hylidae. *A, Hyla femoralis,* 4 miles E. Gainesville, Florida; *B, Acris gryllus dorsalis,* Biven's Arm, Alachua County, Florida; *C, Hyla c. cinerea,* Gainesville, Alachua County, Florida; *D, Pseudacris ornata,* 7 mi. northeast of Gainesville, Florida; *E, Hyla crucifer bartramiana,* Camp Olena, Columbia County, Florida; *F,* MCZ 2277, type ilium of *Hyla goini* nov. sp., L. Miocene, Thomas Farm, Gilchrist County, Florida. The lines represent 1 mm.

(1), *H. septentrionalis* (1), *Pseudacris nigrita* (4), *P. ornata* (3), *P. brimleyi* (1), *Acris gryllus* (3).

The dorsal prominence of *Acris gryllus* is oval and on a rather long base, located in front of, to very slightly behind, the anterior edge of the acetabulum. In addition, the ventral portion of the acetabular expansion is shorter at its base than in *H. goini*. In all the hylids that I have examined, with the exception of *crucifer*, and to some extent *femoralis*, the dorsal prominence is oval, usually with a long base, and with the protuberance of the prominence located considerably higher than in *goini*. In specimens of *H. crucifer*, and some of *femoralis*, the protuberance of the dorsal prominence is relatively small, rounded, not too high, and on a fairly small base. However, the prominence in *crucifer* is anterior to the anterior edge of the acetabulum, and the lower portion of the acetabular expansion is considerably longer and narrower than in *goini*. In *femoralis* the protuberance is higher on the dorsal prominence and the acetabular expansion is also somewhat higher. In *Pseudacris nigrita*, *P. brimleyi* and *P. ornata* the dorsal prominence is rounded, never as oval as in most species of *Hyla* that I have seen. Its base is relatively short and the entire prominence is usually anterior to the anterior edge of the acetabulum. However, *goini* is considerably larger than any modern *Pseudacris*. It is apparently the size of an average specimen of *Hyla cinerea*. It also differs from modern species of *Pseudacris* that I have examined, in the shape of the acetabular expansion which is longer at its base. In addition, the somewhat subtriangular acetabulum apparently separates it from most species of this genus.

In many respects, the ilia of *Hyla* and *Pseudacris* are very similar. This is to be expected if the genera are really as closely related to one another as is generally supposed. The fossil form, *goini*, is clearly allied to one or both of these genera on the basis of its ilial shape. As a representative of the Hylidae in the Lower Miocene it could, conceivably, be ancestral to both genera. The fact that *goini* shows characters found in both modern genera may be indicative of an ancestral position, or simply a reflection of the close relationship which evidently exists between *Hyla* and *Pseudacris*. In any case, *goini* can be reasonably placed in the genus *Hyla* on the basis of its size and the fact that all of its characters are duplicated in one form or another in this genus. Ad-

ditional specimens representing other parts of the skeleton are needed before its exact status can be clearly fixed. Figure 3 compares the ilia in certain hylid frogs, selected to show the typical shape within each species, with the type of *H. goini*.

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BREVIORA

Museum of Comparative Zoology

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FOOD-FINDING BY A CAPTIVE PORPOISE (*TURSIOPS TRUNCATUS*)[1]

BY WILLIAM E. SCHEVILL AND BARBARA LAWRENCE

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INTRODUCTION

It soon appears on acquaintance with porpoises that these animals are well endowed with hearing and sight, and that they use both these senses in their normal environment. A captive *Tursiops truncatus* was confronted with the problem of finding unfamiliar food under varying and sometimes rather complicated circumstances, all unlike the normal hunting of his previous wild free existence. Experiments to find out which sense was relied on most and in what ways it was most useful have shown a wide and not unexpected variation in a single individual. Like man, the animal used all the clues he could get. Sometimes he listened, sometimes he looked, and sometimes he was so busy doing whatever he had last done that he missed perfectly obvious clues.

[1] Contribution No. 832 from the Woods Hole Oceanographic Institution.

Although there was such variation in his responses to similar circumstances that many experiments produced conflicting evidence, there was a certain pattern which makes possible a number of conclusions. When he was finding his food he was most eager, swift, and accurate in coming to the sound of a slap on the water. When he had no such clue he would find the fish, evidently by echolocation, if it was in a region where he expected to find food. His final searching for the fish was by eye, though he could not clearly distinguish his preferred butterfish from other offerings. His willingness to use clues, almost we might say his ability to notice them, depended on his memory and other psychological factors as well as hunger.

EXPERIMENTAL ARRANGEMENTS

Our laboratory on an island at Woods Hole was a pond 34 m. long, 23 m. wide, and 2.5 m. deep, cut off from the sea by a stony beach about 30 m. wide. Our subject was an old bull *Tursiops truncatus*, 203.6 kg. in weight and 267 cm. long, brought here from Florida especially for this experiment. Some injury had damaged his right eye, which we never observed him using, and towards the end of our work his left eye started to cloud over. Whatever the damage was, it did not affect his hearing, which was sharply directional. Temperamentally, he differed from our earlier subject (Lawrence and Schevill 1954), being bold and aggressive, and for this reason was often seen at the surface. Puzzling situations near at hand often caused him to thrust his head above the water, or "souse out" in this way to look, and when further off he would "pitchpole" straight up for a third or more of his length. He learned fast, and while his evident preference for doing as he pleased would make any formal analysis of his responses rather meaningless, this independence gave a much more varied and accurate picture of his inclinations and abilities than we could have obtained otherwise. Since he preferred going hungry to being forced into situations he disliked, the tests we devised were as simple as were consistent with getting reliable answers. Under these circumstances, it soon became clear that in many cases failure on his part to respond was due not to inadequacy of his senses, but to lack of hunger, temporary unwillingness to approach the feeder, or some other non-sensory reason.

The porpoise was ordinarily fed from a punt 3.6 m. long moored against the bank, usually at right angles, but sometimes parallel to it. In some experiments a small dinghy served as a second feeding station. The position of the feeder in the boat varied. The porpoise was fed dead butterfish (*Poronotus triacanthus*) about 8 to 23 cm. long, held in the water by hand, and was called by an acoustic signal made by slapping the water, or by hammer strokes on a partially immersed iron pipe, or by tones (ranging usually between 500 and 30,000 cycles per second) from an audio oscillator through an underwater sound projector; the pipe and oscillator signals were always remote from the feeding station.

Most of our work was done during daylight, so that we could watch where the animal was and how he responded under different conditions. It was not difficult to keep track of him because he frequently showed at the surface. Because porpoises see well both above and under water, we had to be sure than an apparently acoustic response was not in reality visual. This was the easier because his constant swimming kept the water stirred up and very murky. Transparency by Secchi disk from the surface was rarely as great as 70 cm. and often less than 45 cm.; the very unusual maximum was 85 cm. on 19 September. At 11 o'clock on a typical sunny day measurements made by diving after dark-adaptation gave a Secchi disk reading of 23 cm. from the diving mask at a depth of 2.4 m., and 61 cm. at the surafce. Underwater visibility will scarcely exceed the Secchi disk reading, and will be appreciably less for less bright objects.

This, and observations of the porpoise's behavior when he was finding fish by eye, led us to believe that we are conservative in saying that through the water he could not possibly have discerned with any clarity objects as much as 1 m. away from him. As a further check we repeated most of our tests at night.

We selected the pond because of its great freedom from noise-making animals; the beach protected us from most of the noises of the sea outside. Our listening gear included an AX58C Rochelle salt crystal hydrophone and a WHOI sound level meter (Suitcase), and was sensitive enough to pick up very plainly the noise of fine beach sand strewed into the water 20 m. from the hydrophone.

PASSIVE LOCATION

One of the most conspicuous traits of our porpoise was the accuracy and confidence with which he promptly made his way to the place where the water had been slapped. There was no uncertainty or hesitation in his response to such a signal; no matter where he was in the pond, he always came with alacrity when he was thus called unless he was not hungry or there were other obvious psychological reasons for his refusing to do so. While failure to reward response to a remote signal often made him ignore subsequent calls, this was never the case with a slap on the surface. As often as we repeated the slap he would return quickly, though we never called him more than four or five times in succession without giving him a fish.

Not only was he prompt in his response to this slap, but, when conditioned to it, he chose it in preference to other clues. If (as described on p. 8) a fish was slapped in one place and held in the water in another, he would choose to go to the place of the sound instead of to the fish, until he learned this clue was unreliable. His apparent reliance on this signal alone sometimes led him to miss a nearby fish entirely.

The porpoise's hearing was sharply directional and his estimates of range (distance) were very close, as is shown by his repeatedly homing directly on a single slap (with no fish in the water) to well within 20 cm. from ranges often as great as 20 to 25 m. through turbid waters and without coming up to look on the way.

ACTIVE OR ECHOLOCATION

The evidence that our porpoise was echolocating his fish was accumulated over eleven weeks of close observation of his behavior, when an increasing knowledge of what to expect from him under different circumstances made it possible to understand and to check his various capabilities with a fair degree of accuracy.

Early in our work we noticed that our porpoise usually made a characteristic sequence of "creaks" as he came in for a fish, and that in the last meter or so these sounds were matched to horizontal movements of his head. By "creaks" we mean a series

of impulsive clicks made at widely varying repetition rates (from less than 10 to more than 400 per second), the slower ones sounding like knocks and the faster ones like snarls or whines. They have also been called "barks", "snores", "rusty hinge", or "rasping and grating sounds," etc., by various authors, such as McBride and Hebb 1948, Kritzler 1952, and Wood 1954, and have been heard from several odontocetes. Some acoustic details of *Tursiops* calls have been given by Kellogg, Kohler, and Morris 1953. The other common odontocete sound, the whistle-like squeal, was evidently not employed in echolocation, and appears to be primarily communcative. The acoustic details of these sounds will be reported elsewhere.

Before long we noticed that when he was creaking he almost always swam directly to a fish held quietly in the water. When he was not creaking he would not do so. Though this suggested echolocation rather persuasively, we had to be sure that we were not inadvertently giving him other clues and that he was not using sight. His remarkably good hearing and his evident reliance on passive auditory clues made it especially important to make sure he was not coming because he heard us put a fish in water. Very occasionally it seemed highly likely this was just what he was doing, though we ourselves could never detect any sounds, even with our extremely sensitive listening gear. Responses at these few times were discounted. At other times when we were doubtful, we checked his behavior by dipping fish or fingers in and out or dabbling at the surface. This almost never brought him, nor could we get him to come unsignaled to a fish's nose in the water, even though he was coming accurately to a whole fish. Repeated checks also eliminated movements in the boat or the position of the feeder as clues.

The possibility that he was using sight to guide him to a fish had also to be investigated, and we did this in two ways. First of all we devised a series of daytime experiments which, because of the murkiness of the water (see Secchi disk readings), eliminated any possibility that he was using vision to locate his fish from a distance. These experiments are described in some detail below. After we had learned how he reacted to these different situations we repeated the tests at night, with similar results, which are also described below.

Two rather different sets of circumstances stimulated him to rely on echolocation alone in finding his food. Sometimes he used this means to discover whether or not a fish was waiting for him, and sometimes this was the way he distinguished between alternate feeding places.

Echolocation to Determine Presence of Fish

His reliance on echolocation to tell him whether or not a fish was waiting showed in a number of ways. Often, in the absence of an expected signal, he would circle the pond, creaking only as he passed the feeding station. This was anywhere from 1 to 5 meters away, and occasionally farther. If a fish were in the water as he passed, he would turn and swim directly to it; if there were no fish he would go on by. If a fish were slipped as silently as possible (and we believe inaudibly) into the water after he had passed when he was starting to circle away, he would usually turn and come back. We tried this many times on seven different days. Of these the first is especially significant. It was early in our work and was our first attempt to bring him to a fish without a signal, he being then conditioned to come only to the slap of a fish on the water. At first, although he passed nearby creaking, he did not come to the fish, but later that morning he was attracted some of the time. Five days later we tried again, and he had apparently learned not to wait for a signal. By now he would come in for a fish held silently in the water if he was creaking as he passed by; his decision to come on in seemed usually to be made at a distance of less than 5 but occasionally as much as 15 m. This was repeated a number of times during the next four days, and again two months later.

Our evidence that the porpoise was not seeing the fish before deciding to swim to it was partly his excessive distance when he turned toward it and partly the fact that he often had his bad eye towards the punt as he passed.

As well as using echolocation to find fish when he suspected fish should be available, he also used this means to confirm the reliability of a signal. While he almost never refused to come to the sound of a fish slapped on the water, various circumstances on several occasions made him uncertain about other signals. Early in his training he learned that an oscillator note or pipe-banging in various parts of the pond meant that he would get a

fish at the feeding station, and, like our earlier porpoise, on being signaled with no fish in the water, he would make his way to the proper place to get it. Sometimes, however, he ignored the remote signal until there was a fish in the water as well. With this to convince him he would come unhesitatingly. This reaction was especially clear on four occasions when we had made changes which he did not like in the feeding station. These were all times when he was in good health and hungry, and the remote signal was one we knew he could hear. Until he was accustomed to the new arrangement, no matter how often we called, he always waited till there was a fish in the water before responding to the signal. The first time we had to signal six times with a fish in the water before he began to come on signal only. The other three occasions, at a much later date, were at successive feedings on two days. The first morning it took twelve fish, that afternoon three, and the following morning seven before he would come with no fish in the water. At these times he was creaking as he swam and for the most part responded to the signal by starting towards the feeding station, but with no fish in the water he usually turned away at 2½ meters or more, though sometimes he circled as near as a meter and a quarter. When he was thus relying on echolocation to tell him of the presence of a fish, he rarely troubled to look above the surface. Later, when he was coming on the remote signal with no fish held in, he often soused out of the water on the way in, eyeing the situation from a distance of ten or more meters.

His ability to arrive at a fish he could not see was further demonstrated one afternoon when his left eye failed. At that time, on a remote signal, he repeatedly swam directly to fish held anywhere over a 5½ m. radius.

Echolocation to Distinguish Between Alternate Feeding Places

To test his use of echolocation, two feeders slapped fish simultaneously on opposite sides of the punt and then one held a fish in the water while the other held a hand out over the water as if feeding. The distance between slaps was about 2 m., and a net projecting 2.5 m. from the end of the punt and hanging to the bottom of the pond prevented the porpoise from circling close

to investigate by eye. We alternated feeding in irregular fashion and the feeders often exchanged places in order to eliminate any other clues. The first time we tried this he came to the correct side 24 times and the wrong side 11, the next time he made 45 correct responses and 13 wrong. His behavior was similar on both occasions. He never ignored a summons and always came directly and fast, creaking as he approached deep. The Secchi disk reading was 61 cm., and he was at the very least 2.5 m. from the fish when he had to decide which side of the net to go. In contrast to his behavior with a remote signal, he made no optical checks on the way in, though sometimes when feeding was slow he pitchpoled out, looking at us. We cannot say how often his wrong responses were caused by the net interfering with his sound patterns. We suspected this on some occasions, while other errors probably are evidence that his echolocation was not perfect.

PASSIVE VERSUS ACTIVE LOCATION

Experiments to find out what kinds of clues were most successful or preferred produced interesting results. One rather simple but very instructive one, here called the A-B experiment, consisted of slapping at A and putting a fish in the water at B or vice versa, with the distance between A and B farther than he could see. This, with minor variations, we tried many times on each of fifteen different occasions, and though his responses varied, they made a very neat pattern. The first time we tried it, and when we returned to it after a period of other work, he would always swim, creaking, directly to the point of slap, search diligently there, and usually swim away unrewarded. If, in leaving, he found the fish, he would thereafter search at the point of slap and then swim directly to the fish no matter how we varied the relation of these two places to each other. Finally, it was possible to destroy his confidence in the slap as a worthwhile clue, and then for the most part he would go directly to the fish. When he swam directly to the fish there was no possibility that memory could have guided him, because the fish might have been anywhere over a six meter stretch. Nor could vision have helped, because he was never nearer than 6½ meters when we signaled, and usually a great deal farther away. When he

looked first at the point of slap and then went on to find the fish, not pausing on the way, the distance between the two places (minimum 1.3 m., usually more, sometimes as much as 5.2 m.) seemed to preclude the possibility of his being guided by sight, the more so because in this secondary finding of a fish it made no apparent difference whether he approached with his bad or his good eye towards it.

In one variation of the A-B experiment we fixed the points 2 m. apart. If we slapped at A with the fish in the water at B or vice versa, he went directly to the fish; if we slapped with no fish in the water, he searched at the point of slap but never investigated the alternate place as he left unrewarded; if we let him search at the point of slap and then eased a fish quietly into the water at the other place, he would immedately go to it. On a number of other occasions we tried this third modification, varying the place where we put the fish, and he always creaked his way to it. This is not entirely conclusive, as there is a small but unlikely possibility that he might have heard the fish put in, though our efforts to check this led us to believe that this was not passive location (cf. below, p. 11).

NIGHT TESTS

All of the experiments described above were carried out during the day. We also tried most of these same experiments on dark nights and found the results closely paralleled our daytime observations. On two nights when we tried to get him to take fish unsignaled, he came, apparently directly, making about ten successful runs each time, though he sometimes swam past, creaking, without coming in, and sometimes appeared to search near the fish without taking it. On two other nights we tried the A-B experiment, the first time feeding ten fish which he readily found, though it was too dark for us to see if he made a preliminary search at the point of slap. During the second and more prolonged A-B experiment he repeatedly came to the fish, not the point of slap, especially when he came from far down the pond. Occasionally he searched first at point of slap, and twice he missed the fish entirely. The last night feeding was partly from the dinghy in the middle of the pond. Two slaps informed him that fish were to be had in the vicinity; thereafter

on remote signal he came directly and accurately seven times in a row to a fish held anywhere in a radius of 6 m. Later, when we fed from the punt, he responded to the correct side 6 times, to the wrong side 2, and did not respond at all 2 other times.

VISION

While sound was important to our animal, we have good evidence that he relied greatly on vision as well, both above and beneath the surface of the water. A bad if not completely blind right eye made him left-sided in his approach to things he wished to see. This was a convenient check when we could not see his eye rolled towards what interested him.

When on arrival from Florida he was dumped into the pond, his first check of his new surroundings was optical. As soon as he hit the water he swam off fast and silently, sousing high out of the water and blowing frequently, with his good eye towards the shore. It was three minutes before we heard him utter a single sound, and nearly two minutes more before he spoke up as loudly and persistently as he did for most of the rest of his stay. It was hard not to think that he was looking over his new surroundings, perhaps searching for a break in the beach. His obvious awareness of things on the shore showed in many ways. During his first two weeks in the pond there were often clusters of people working at different places along the bank. At such times he often blew near them, rolling a little on his right side so that his left eye cleared the surface. Soon he took his surroundings more for granted and his inspections of the shore were less frequent, though he quickly noticed changes. Possibly also with the passage of three or four weeks he became more accustomed to his blind eye; at all events he rolled more often on an even keel, and without bringing his good eye out of the water.

While this kind of check on his surroundings was not important in helping him find his food, it did have a bearing on his behavior at feeding time. Too many people on the bank near the feeding station made him shy, and he would come in deep and depart hastily. The presence of someone in the boat from which we fed aroused his interest, and he would blow nearby, looking. Sometimes it even seemed as if he reacted differently to different feeders.

When we actually called him to eat with the well-understood slap of a fish on the water, he rarely troubled to make an optical check on the way in as he did with a remote signal, but swam directly from wherever he was, to collect his morsel. At other times when he was less sure of the summons, or when we were slow sending signals, he rolled high, looking towards the feeder, or soused out to see what was going on. On occasions when he was more than ordinarily curious, he would pitchpole out of water as far as his flippers, with his good eye looking ventrad towards us.

In addition to keeping track of things above the water, under ordinary circumstances he relied on vision to a great extent in his final accurate taking of a fish from the feeder. Often we could see his eye rolled forward towards the fish. As with our earlier animal, space permitting he would turn over on his side when close, and in the eleven weeks we fed him he only once took a fish with his right eye up. When he lingered at the end of the boat waiting for a fish it was always with the left eye up. When we fed him in a sort of narrow stall 1.2 m. wide so that he did not roll over as he approached, he swung his head from side to side farther to the right than to the left, so that his left eye was in position to scan both sides of the stall as well as the end of the punt.

Fish put in on his blind side or above his head did not attract his attention unless they were splashed. Fish put in nearby and directly in front of him he also took in more fumbling fashion, and on at least two occasions actually bumped into them before seizing them. On the other hand, anything within his range of vision quickly caught his attention. When a fish was moved 15 cm. or so above the water he would follow it with his eye and when it was held lower would put his snout out to snatch it.

Repeatedly, we found a difference in his fish-taking when visibility was especially poor or he himself not seeing well. This usually meant that he would begin his search farther from the fish, nodding his head more widely as he approached slowly, and would be more hesitant about taking the fish, sometimes fumbling and dropping it. A few times, when the fish were small, he missed them entirely. This was true not only when the water was murky, but also when we held the fish deep.

These indications that vision is important in his ultimate locat-

ing of the fish were borne out by his behavior on two separate occasions when the salinity in the pond was down and the water dirty. At these times it appeared that his left eye also was not seeing well. On the first occasion, for three days his fish-finding was less accurate and his search wider than was usual. Once he even bit at the corner of the punt, though the fish was less than 50 cm. away. The other occasion was one afternoon when his left eye failed; then, he approached with it shut, and would lie left side up at the end of the punt, not noticing the fish when it was moved above the surface, but coming to grab it clumsily when it was put in the water. Once when he swam past a fish in the water, he worked his way back to it slowly with very exaggerated head noddings and took the fish awkwardly deep in his mouth. Though his sight recovered after this, he never seemed to see out of his left eye as well as in the beginning. A whitish spot began to form and he would partly close his eye against a low sun, whether because it hurt or dazzled was impossible to tell. At these times his fish-taking was again less accurate, and contrasted with a greater ease when the sun was not shining directly in his eye.

While taking the fish was easier if he could rely on seeing it, he apparently could not discriminate between objects very well. Squid and flattened tin cans don't resemble butterfish much, but even after he had found out he did not like the first two he repeatedly took them in his mouth when they were offered instead of fish. In the same way he would bite at floating vegetation near the boat, at bits of rope, or even at a rusty pail. Size seemed easier for him to tell, and he not infrequently appeared to inspect and then leave small butterfish, about which he was not enthusiastic.

DISCUSSION

In this study we took a gregarious free-ranging animal that in nature is almost always found at least in small groups and often in immense herds, and placed it in solitary confinement. Whereas wild porpoises hunt live food that occurs in schools, ours was obliged to take single dead fish from the hand. Moreover, the single fish was usually close to a boat or a bank, instead of in the more open water to which wild *Tursiops* are accustomed.

Perhaps the most striking result of our work is the great variation observed in the way our single animal sought his food. His primary reliance on passive auditory clues could have been due to the small size of his target and to the confused echo patterns in the pond. Nevertheless, evidence accumulated that he often echolocated the food we offered him, thus supporting the widespread supposition (for example, Kellogg, Kohler, and Morris 1953) that this was how cetaceans hunted. The sounds the porpoise made at these times were faint; indeed, only the very loudest were audible to a submerged man, and, in fact, were picked up by our sensitive listening gear only because we at last had a porpoise in a really quiet place. Thus we learned that the supposed taciturnity of solitary porpoises (Lawrence and Schevill 1954, pp. 229-231) is rather a relative matter; it appears that they merely speak very softly. The noisy listening conditions of our previous experiment had led us into error when we reported (op. cit., p. 229) "the complete absence" of evidence for echolocation although we cited some, unrecognized, at the bottom of page 227.[1] The only evidence we had been aware of was in McBride's posthumous note (in press) on net avoidance (what our porpoise taught us about this will be reported in another paper).

To demonstrate whether an animal is using echolocation, the most definite way is to show that acoustic interference affects performance. Thus Griffin and Galambos (1941) and Griffin (1953) by deafening bats and nocturnal birds showed that these animals then collided with obstacles that, undeafened, they had avoided. It is of course necessary to make sure that other senses, such as smell (evidently not available to cetaceans) or sight, have been excluded. Furthermore, it must be shown that sounds suitable for echolocation are produced. This last point is abundantly proved for porpoises (e.g., Wood 1952, 1954). The role of sight in our porpoise's food-finding has been discussed under Vision. We did not deafen our animal or interfere with his sound production.

Therefore, our evidence for echolocation by the porpoise is essentially that he consistently found fish when we could convince ourselves that no other clue (sight or sound not made by the porpoise himself) was available.

[1] On page 414 of an article published while this paper was in press, Griffin (1956. Hearing and acoustic orientation in marine animals. Deep-Sea Research, *3*, Suppl. (1955), pp. 406-417) suggests that just such an improved signal-to-noise ratio might reveal evidence of echolocation by porpoises.

The porpoise's performance seemed poorer on targets behind him, particularly at the longer ranges. In general, the creaks with the higher repetition rate were heard at the shorter ranges, but this orderly arrangement was usually confused, perhaps because of additional targets. At close range the creaks were timed to a horizontal sweeping of the head (nodding when on his side). These observations may be interpreted as indicating directionality, presumably in his sound production. We have not investigated this arresting possibility further, except to consider that perhaps the pneumatic cephalic sinuses may modify the radiation of sound from the larynx.

Echolocation was evidently not a perfect method for our porpoise. Perhaps the fault lay in the special conditions in the pond, where the presence of multiple reflections from the stones in the banks and bottom must have confused the echoes. The primary target was a small fish; behind it was the punt, and behind that was the shore. We noticed that when being fed from the small dinghy (with so much less boat in the water to return an echo), he ordinarily came right to the fish with less hesitation than when feeding at the punt. These are indications that echolocation did not give him clear and unequivocal information (human users of this technique will sympathize).

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BREVIORA

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A REVISION OF THE GENUS *BRACHYMELES* (SCINCIDAE), WITH DESCRIPTIONS OF NEW SPECIES AND SUBSPECIES

By WALTER C. BROWN [1]

INTRODUCTION

The genus *Brachymeles* was erected by Duméril and Bibron (1839) to accommodate a single species, *B. bonitae,* of this unique group of Philippine skinks. Subsequently, *B. bicolor* was described by Gray (1845) as the type of the genus *Senira; B. gracilis* and *B. schadenbergi* were described by Fischer (1885); and Taylor described *B. elerae* and *B. burksi* (1917), *B. suluensis* and *B. vermis* (1918), *B. boulengeri* (1922) and *B. pathfinderi* and *B. wrighti* (1925). In 1922 Taylor correctly assigned *B. suluensis* to the synonymy of *B. gracilis* and also pointed out that *B. boulengeri* is closely related to the latter. It now appears that *B. boulengeri* is probably best regarded as a geographically isolated population which is only subspecifically differentiated from *B. gracilis.* It differs only in minor characteristics from the nominate form and does not overlap in range with any other population of this species as it does with *B. schadenbergi.* A re-examination of the type of *B. bonitae,* for which assistance I am deeply indebted to Dr. Jean Guibé, indicates that *B. burksi* is

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conspecific with it. Two additional species are described in the present paper.

The members of this genus are secretive, burrowing lizards that exhibit to a high degree elongation of the body and reduction of limbs, eyes, and ears — specializations that in general characterize other strictly burrowing skinks. The most highly specialized forms have rarely been encountered by field zoologists. As a result, several of the species are represented by only a few individuals and nothing of their inter-island variation is known, assuming for the moment that their range, as in the instance of *B. bonitae*, includes more than one island. Contrarily, at least five of these highly specialized species are known only from type localities, and the possibility also exists that many of these populations have very restricted ranges and are represented by relatively small numbers. Substantiating evidence can be pointed out in the instance of *B. tridactylus*. Four examples of this species were collected in the mountains of southern Negros Oriental, some 20 kilometers west of Bais, during a field period of about two weeks in January and March, 1955, whereas no specimens were uncovered in the Cuernos de Negros area of the same mountain range, about 50 kilometers to the south, although this area was much more thoroughly investigated over a nine month period from July, 1954 to March, 1955. The author is of the opinion that this species does not occur in the Cuernos de Negros area. Other species, as *B. gracilis* and *B. schadenbergi* are widespread within the archipelago, and sufficiently large samples are available from several of the islands that well differentiated populations can be recognized. These are regarded as distinct subspecies.

No member of the genus has been recorded from outside of the Philippine Archipelago. However, in view of its wide range within this group of islands, including the Sulus and Palawan, both of which are in close proximity to Borneo, it is not improbable that the genus may occur in North Borneo, at least.

Several of the more specialized species can be readily distinguished on the basis of the degree of reduction of the limbs and elongation of the body. Greater difficulty exists in the recognition of valid species and subspecies of the pentadactyl forms. Part of the difficulty is due to the fact that certain of the differentiating characters are not easily quantified, and other, fre-

quently used, key characters may hold for the separation of populations of certain species on a given island, but have been found not to be of value when one is concerned with populations of the same species occurring on a different island. It is hoped that the extent of our present knowledge of the variability of these species may have overcome this difficulty.

In the course of the present study 266 specimens have been examined. The name of the institution in whose collections cited specimens are deposited is, in most instances, abbreviated as follows:

C.A.S., California Academy of Sciences, San Francisco, California

C.N.H.M., Chicago Natural History Museum, Chicago Illinois

M.C.Z., Museum of Comparative Zoology, Cambridge, Massachusetts

N.H.M.S.U., Natural History Museum of Stanford University, Stanford, California

S.U., Silliman University, Dumaguete City, Negros Oriental

SYSTEMATIC DISCUSSION

Brachymeles Duméril and Bibron

Brachymeles Duméril and Bibron, 1839, Erpt. Gen., **5**: 776 (type species: *Brachymeles bonitae* Duméril and Bibron, 1839, by monotypy).

Senira Gray, 1845, Cat. Lizards Brit. Mus.: 98 (type species: *Senira bicolor* Gray, 1945, by monotypy).

Brachymelus Agassiz, 1846, Nomen. Zool. Index Univ.: 51 (emendation).

Diagnosis and definition. Pterygoid and palatine bones not in contact mesially, both without teeth; maxillary and mandibular teeth, moderate, conical; body elongate; limbs reduced or absent; eye small; lower eyelid scaly; external ear opening small or absent.

The following key will serve to distinguish the known species of the genus *Brachymeles*.

1. Limbs absent ..... *B. vermis*
   Limbs present 2
2. Limbs pentadactyl 8
   Either fore or hind limbs or both with less than 5 digits 3
3. Digits entirely absent or a single vestigial claw present .. *B. bonitae*

Two or more digits present (frequently represented only as clawed vestiges) 4

4. Limbs with 2 digits ..... *B. samarensis* sp. nov.
Limbs with more than 2 digits 5

5. Limbs with 3 digits ..... *B. tridactylus* sp. nov.
Limbs with more than 3 digits 6

6. Fore limbs with 5 digits; hind limbs with 4 ..... *B. pathfinderi*
Fore and hind limbs with 4 digits 7

7. Midbody scale rows -22-; scale rows between the parietals and the base of the tail 83-85 ..... *B. elerae*
Midbody scale rows -28-; scale rows between the parietals and the base of the tail -102- ..... *B. wrighti*

8. Limbs short, length of the hind limb about 9 to 12 per cent of the snout-vent length for mature individuals; number of scale rows along the vertebral line between the parietals and the base of the tail 92-94 ..... *B. bicolor*
Limbs moderate, length of the hind limb about 16 to 25 per cent of the snout-vent length for mature individuals; number of scale rows along the vertebral line between the parietals and the base of the tail very rarely as great as 75 (generally 63 to 73) 9

9. Size at maturity 75-129 mm. snout-vent length for 28 specimens; supranasals large in contact (30 of 45 specimens examined) or narrowly separated; number of midbody scale rows 26-32 (mean $= 27.9 \pm 0.265$) for 49 specimens; number of middorsal scale rows between the parietals and the base of the tail 67-73 (mean $= 69.1 \pm 0.214$) for 49 specimens; venter and lower lateral surfaces very light with no or very few dark spotted scales. ..... *B. schadenbergi*

Size at maturity 57.5 to 95 mm. for 72 adult specimens; supranasals moderate, generally rather widely separated, in contact in only 2 out of 50 specimens examined; number of midbody scale rows 24-28 (mean $= 26.0 \pm 0.104$) for 81 specimens; number of middorsal scale rows between the parietals and the base of the tail 63-69 (mean $= 65.6 \pm 0.132$) for 100 specimens; lower lateral surfaces and frequently venter with numerous dark Spotted scales (except in *B. gracilis boulengeri*) ..... *B. gracilis*

Brachymeles vermis Taylor

Brachymeles vermis Taylor, 1918, Philip. Journ. Sci., **13**:255 — Bubuan Id., Sulu Archipelago.

Material examined. Jolo Id. 5 (C.A.S. 60720-22, 60857-58); Bubuan Id., Sulu Arch. 1 (C.A.S. 62489).

Diagnosis. Habitus very slender; snout to vent length 64-76 mm. for 3 mature specimens; limbs absent; no ear opening; no postnasal; 22-24 scale rows around the middle of the body (6 specimens); 104-109 scale rows along the middorsal line between the parietals and the base of the tail (6 specimens).

Range. Known from Bubuan, Jolo and Sulu Islands, Sulu Archipelago.

Brachymeles bonitae Duméril and Bibron

Brachymeles bonitae Duméril and Bibron, 1839, Erpet. Gen., **5**:777 — Manila, Luzon Island.

Brachymeles burksi Taylor, 1917, Philip. Journ. Sci., **12**:275 — Sumagui, Mindoro Island.

Material examined. Holotype (examined by Dr. Jean Guibé); Mindoro Id. 3 (C.A.S. 62064, C.N.H.M. 22525, S.U. R-20); Luzon Id. 3 (C.A.S. 61376-77, 62578); Kalotkot Id. 2 (C.A.S. 60556-57); Polillo Id. 3 (C.A.S. 62278-79, 62575).

The single specimen (No. 1151, now C.A.S. 62578) referred to *B. bonitae* by Taylor (1917, 1922), with which he compared *B. burksi* when describing that species, is somewhat aberrant, whether compared with the type of *B. bonitae* or *B. burksi;* it differs primarily in the much greater number of scale rows along the middorsal line between the parietals and the base of the tail, 113 instead of 100 to 106 for 11 specimens of *B. bonitae* (holotype 104). The fusion of the first pair of lower labials with the mental, illustrated by Taylor, is characteristic of the type of *bonitae* and also of 6 of the 9 specimens of *B. burksi* examined for this character. Whether or not the greater number of middorsal scale rows is actually an individual aberration or characterizes a more or less isolated population of *B. bonitae* cannot be determined at this time.

Diagnosis. Habitus very slender; snout to vent length 57-82.5 mm. for 6 mature specimens; limbs reduced to vestiges without evidence of toes or with a single claw, length of hind limb about 3.5 to 4.3 per cent of the snout-vent length (4 specimens); no ear opening; no postnasal; 22-23 scale rows around the middle of the body for 10 specimens; 100-106 scale rows along the middorsal line between the parietals and the base of the tail. One specimen (C.A.S. 62578) from Los Banos, Luzon, is far out of

this range, exhibiting 113 middorsal scale rows, but as noted above, is tentatively referred to this species.

Range. Known from Luzon, Mindoro, Polillo and Kalotkot Islands in the northern part of the archipelago.

Brachymeles samarensis sp. nov.

Holotype. C.N.H.M., No. 44472, a juvenile, collected by G. N. Rysgaard, at Guiuan, Samar Island, Philippine Islands, January 10, 1945.

Diagnosis. A slender *Brachymeles* with very short limbs, possessing only two reduced digits on both the fore and hind limbs; midbody scale rows -22-; scale rows along the vertebral line between the parietals and the base of the tail -86-.

Description. A *Brachymeles* of very slender habitus; head little wider than the body, tapering anteriorly to the rounded snout; rostral large, in broad contact with the frontonasal; nostril in a small nasal; no postnasal; supranasals widely separated in the midline; prefrontals of moderate size, widely separated; 5 supraoculars, anterior two in contact with the frontal; 6 superciliaries; frontoparietals in contact; interparietal large, round-pointed posteriorly; parietals in contact posterior to the interparietal; a pair of nuchals which are narrower than the parietals; two frenals, anterior slightly longer and wider than the posterior; first upper labial largest, fourth beneath the orbit; no external evidence of ear; number of scale rows around the middle of the body -22-, number of scale rows along the vertebral line between the parietals and the base of the tail -86-; limbs very short, length of hind limb about one fifteenth the snout-vent length; digits reduced to 2 clawed stumps on each foot.

Measurements of holotype. Snout to vent 43.5 mm.; length of hind limb 3 mm.

Color (in preservative). Dorsal and lateral surfaces are dark yellowish brown, each scale generally being dark spotted posteriorly; the venter is only slightly lighter.

Relationship. It would appear to be more closely related to *B. elerae* than to *B. bonitae* for, although the extent of reduction of the limbs and digits is somewhat intermediate, the elongation of the body as measured by the number of middorsal scale rows between the parietals and the base of the tail is essentially

the same as that of *B. elerae*, 86 as compared to 83-85 for 2 specimens of the latter. The number of scale rows between the parietals and the base of the tail for 11 specimens of *B. bonitae* is 100-106.

Range. Known only from the type locality.

Brachymeles tridactylus sp. nov.

Holotype. N.H.M.S.U. No. 18354, a probably mature female, collected 1 to 3 kilometers northwest of Mayaposi spring, about 20 kilometers west of Bais, Negros Oriental, at an altitude of about 2000 feet on January 12 to 17, 1955, by Mr. Filomeno Empeso.

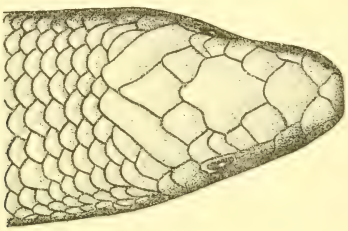

Fig. 1. Dorsal view of head of *Brachymeles tridactylus*.

Paratypes. N.H.M.S.U. Nos. 18355-56 and M.C.Z., No. 54258, collected at the same locality as the holotype.

Diagnosis. A slender *Brachymeles*, with short limbs, possessing three reduced, clawed digits on both the fore and hind limbs; scale rows 22-24; scale rows along the middorsal line between the parietals and the base of the tail 95-103.

Description. A *Brachymeles* of very slender habitus; head not or scarcely wider than the body, tapering anteriorly to a narrow, truncate margin of contact with the frontonasal; nostril in a minute nasal; supranasals not in contact in the midline for any of the present series; prefrontals moderate, rather widely separated; 4 supraoculars, anterior two in contact with the frontal; 5 supereiliaries; frontoparietals narrowly or moderately

separated in the midline; interparietal large, rather pointed posteriorly; parietals meeting posterior to the interparietal; a distinct pair of nuchals in only one specimen; two frenals, nearly equal, or the anterior slightly shorter and wider; first upper labial largest, fourth beneath the orbit; no external evidence of ear; number of scale rows around the middle of the body 22 to 24; number of scale rows along the vertebral line between the parietals and the base of the tail 95 to 103; limbs much reduced, the length of the hind limb about one sixteenth to one twentieth the snout-vent length; digits reduced to three clawed stumps on each foot.

Measurements of holotype. Total length 106 mm.; snout to vent 65 mm.; axilla to groin 49 mm.; snout to forelimb 13 mm.; length of hind limb 4 mm.

The largest specimen measures 78 mm. from snout to vent.

Color (freshly preserved material). Dorsal and lateral surfaces are nearly chocolate brown to dark slate brown; the venter is somewhat lighter in shade. Actually the basal part and center of each scale is pigmented, the overlapping lateral and distal edges are not.

Relationship. This species is apparently most closely related to *B. bonitae* from which it differs primarily in less reduced limbs and the presence of three stump-like, clawed digits on each limb. *B. bonitae* has lost all the digits or retained a vestige of only one at the tips of the minute limbs.

Range. Known only from the type locality.

Brachymeles elerae Taylor

Brachymeles elerae Taylor, 1917, Philip. Journ. Sci., 12:273 — Philippine Islands.

Material examined. Luzon Id. 2 (C.A.S. 61499-500).

Diagnosis. Habitus very slender; snout to vent length 69-71 mm. for 2 mature specimens; limbs greatly reduced with vestiges of 4 clawed toes on both fore and hind limbs; length of hind limb 7.2 to 9.3 per cent of the snout-vent length (4 specimens); no ear opening; no postnasal; -22- scale rows around the middle of the body; 83-85 scale rows along the middorsal line between the parietals and the base of the tail.

Range. Known definitely from Balbalan, Mountain Province, Luzon Island.

Brachymeles wrighti Taylor

Brachymeles wrighti Taylor, 1925, Philip. Journ. Sci., **26**:106 — Trinidad, northern Luzon Island.

Material examined. Holotype (M.C.Z. 26589; examined by Mr. Arthur Loveridge).

Diagnosis. Habitus slender; snout-vent length 130 mm. for one specimen; limbs greatly reduced with 4 clawed toes on both fore and hind limbs, length of hind limb 7.5 per cent snout-vent length (1 specimen); ear opening questionable because of injury; no postnasal; -28- scale rows around the middle of the body; -102- scale rows along the middorsal line between the parietals and the base of the tail.

Range. Known only from the mountains of northern Luzon Island.

Brachymeles pathfinderi Taylor

Brachymeles pathfinderi Taylor, 1925, Philip. Journ. Sci., **26**:104 — Glan, Cotabato Province, Mindanao.

Material examined. Holotype (M.C.Z. 26581; examined by Mr. Arthur Loveridge); Mindanao 2 (M.C.Z. 26582-83).

Diagnosis. Habitus slender; snout to vent length 58-61 mm. for 3 mature specimens; limbs greatly reduced with vestiges of five clawed toes on the fore limbs and four on the hind limbs, length of hind limb 13.6-17.2 per cent of snout-vent length (3 specimens); ear opening minute; no postnasal; 22-23 scale rows around the middle of the body; 59-67 scale rows along the vertebral line between the parietals and the base of the tail.

Range. Known only from the type locality.

Brachymeles bicolor (Gray)

Scincs bicolor (part), Gray, 1845, Cat. Lizards Brit. Mus.: 98 — Philippine Islands.

Material examined. Holotype and one additional specimen (examined by Mr. J. C. Battersby).

Diagnosis. Habitus slender; snout to vent length 155 mm. for 2 mature specimens; limbs reduced with 5 clawed toes present on each foot, length of hind limb 9.7 to 11 per cent of snout-vent length (2 specimens); -28- rows of scales around the middle of

the body; 92-94 rows of scale along the vertebral line between the parietals and the base of the tail.

Range. Early records are given as from the Philippine Islands. More definite information as to the distribution of this species can not be stated at this time.

Brachymeles gracilis (Fischer)

Several populations of this species exhibit rather conspicuous and constant differences in color pattern and in certain instances in scalation or other characters. The Negros population does not exhibit the narrow, dorso-lateral light stripe which in general characterizes other known populations. The venter and lower lateral surfaces of the Polillo population are very much lighter in color than is true of the Mindanao-Sulu population. The dark spotting of the venter is somewhat intermediate for examples from the Negros and Bohol. The postnasal is small and does not contact the second upper labial in the Mindanao-Sulu population, but is larger and in contact with the second upper labial in most examples of the other known populations. Also as pointed out by Taylor (1922), the ear opening is better developed in *B. g. boulengeri* than in *B. g. gracilis.*

The population from Bohol Island is in closer agreement with regard to color pattern, distinctness of the dorso-lateral stripe and the size of the postnasal shield with the population of the northern islands (Luzon and Polillo) than it is with that of Mindanao to the south, and is referred to the subspecies *boulengeri* Taylor which was described from Polillo Island. If this interpretation is correct, intervening islands of Leyte and Samar are in all probability occupied by this subspecies. The differences in the number of midbody scale rows and the number of middorsal scale rows between the parietals and the base of the tail exhibited by populations of different islands are not significant (Table 1).

Brachymeles gracilis gracilis (Fischer)

Eumeces (*Riopa*) *gracilis* Fischer, 1885, Jahrb. wiss. Anst. Hamburg, **2**: 85 — Mindanao Island.

Brachymeles suluensis Taylor, 1918, Philip. Journ. Sci., **13**:254 — Bubuan Island, Sulu Archipelago.

Material examined. Basilan Id. 2 (C.A.S. 60365-66); Mindanao Id. 32 (N.H.M.S.U. 18596; C.A.S. 15567; C.N.H.M. 52637, 52642-52, 52654-70, 52800).

Diagnosis. Habitus rather slender; snout to vent length 57.5-82 mm. for 10 mature specimens; length of hind limb 15.3 to 19.2 per cent of the snout to vent length for 10 adults; postnasal short, not in contact with the second upper labial in any of 30 specimens examined for this character; 24-26 scale rows around the middle of the body for 36 specimens; 64-69 scale rows along the middorsal line between the parietals and the base of the tail for 36 specimens; narrow dorsolateral light stripe generally present, extending anteriorly to the posterior edge of the orbit and posteriorly to the groin or nearly so; lower lateral surfaces dark spotted; midventral region distinctly dark spotted (24 out of 30 specimens), the dark spots generally occupying the basal and central portion of each scale.

Range. Known definitely from the Sulu Archipelago and Mindanao.

Brachymeles gracilis boulengeri Taylor

Brachymeles boulengeri (part) Taylor, 1922, Philip. Bur. Sci. Pub. No. 17:246 — Polillo Island.

Material examined. Polillo Id. 6 (C.A.S. 62272-77); Luzon Id. 2 (C.A.S. 61096-97); Bohol Id. 24 (S.U. R-353; N.H.M.S.U. 18271-76, 18707-11, 18714-20; M.C.Z. 54252-3).

Diagnosis. Habitus rather slender; snout to vent length 61-92 mm. for 19 mature specimens; length of the hind limb 17.9-23.8 per cent of snout-vent length for 19 mature specimens; postnasal long, in contact with the second supralabial in 24 of 26 specimens examined; 24-28 scale rows around the middle of the body (mean $= 26.1 \pm 0.175$) for 27 specimens; 63-66 scale rows along the middorsal line between the parietals and the base of the tail (mean $= 64.2 \pm 0.198$) for 27 specimens; narrow dorso-lateral stripe (in life near to Monkey skin or Vassar tan, Maerz and Paul, 1930, pls. 6 and 10) generally present (27 out of 28 specimens), extending anteriorly onto the supraorbital region and posteriorly to the groin (this stripe is generally more distinct than in *B. g. gracilis*); lower lateral surfaces dark spotted; venter with moderate dark spotting or with such spotting absent.

Table 1
Comparison of subspecies of *Brachymeles gracilis*

	No. of midbody scale rows	Dorsal scale rows between parietals and base of tail	Dorso-lateral stripe present
B. g. gracilis (Mindanao and Basilan)	R = 24-26 M = 25.6 ± 0.197 N = 36	R = 64-69 M = 66.4 ± 0.201 N = 36	Yes
B. g. boulengeri (Polillo)	R = 24-26 M = 25.7 ± 0.305 N = 6	R = 64-66 M = 65.2 ± 0.367 N = 6	Yes
B. g. boulengeri (Luzon)	R = 26,26 N = 2	R = 63,65 N = 2	Yes
B. g. boulengeri (?) (Bohol)	R = 24-28 M = 26.2 ± 0.158 N = 21	R = 63-66 M = 64.0 ± 0.199 N = 21	Yes
B. g. taylori (Negros)	R = 24-28 M = 26.5 ± 0.097 N = 49	R = 64-68 M = 65.6 ± 0.150 N = 49	No
B. g. taylori (Mindoro)	R = 26 N = 1	R = 66 N = 1	No

R = range, M = mean, N = number of specimens

Color (freshly preserved material). The following notes were based on material which had been in preservative only a day or two. Six to 8 middorsal scale rows are Natal Brown to Chestnut (Maerz and Paul, pl. 7), not uniform but each scale with a darker brown blotch at the base. A dorso-lateral stripe (generally one and a half scale rows in width anteriorly and up to one and two half scale rows posteriorly) is somewhat variable usually near Monkey skin or Army brown (Maerz and Paul, pls. 5 and 6). Five to 7 lateral rows exhibit prominent, dark brown spots; the venter is Rose tan (Maerz and Paul, pl. 12), occasionally with small brownish spots. Four or 5 rows on the chin, posterior to the mental, are dusky or brownish.

Range. Known from Polillo, Luzon and Bohol Islands. The latter population is assigned to this subspecies with some reservations, pending the time when collections are available for comparison from the islands of Samar and Leyte.

Brachymeles gracilis taylori subsp. nov.

Brachymeles boulengeri (part) Taylor, 1922, Philip. Bur. Sci. Pub. No. **17**:246.

Holotype. N.H.M.S.U., No. 18615, a male, collected by W. C. Brown and D. S. Rabor on low ridge on the north side of the Maite River, about 13 kilometers west of Dumaguete on Cuernos de Negros, Negros Oriental, July 4, 1954.

Paratypes. Negros Id. 126 (N.H.M.S.U. 17954-55, 18611-14, 18616-24, 18626-28, 18630-31, 18633-37, 18664-80, 18694-700, low

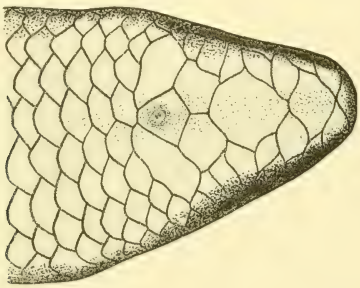

Fig. 2. Dorsal view of head of *Brachymeles gracilis taylori.*

ridge north of the Maite River, Cuernos de Negros, about 3-7 km. west of Luzuriaga, Negros Oriental, July, 1954 to February, 1955; 18597-18604, 18659-63, high ridge north of Maite River and on north slope of north peak of Cuernos de Negros, about 6-8 km. west of Luzuriaga, Negros Oriental, February and March, 1955; 18638-58, 18691-93, 18728, 18748-50, ridge, south of Maite River, east slope of Cuernos de Negros, about 4 to 7 km. west of Luzuriaga, Negros Oriental, November, 1954, to March, 1955; 18686-88, east side of Cuernos de Negros, Negros Oriental; 12027, 12224, 12226, Dumaguete environs, Negros Ori-

ental, August, 1940; 18751, 18729-32, lowlands 2 to 6 km. west of Dumaguete, Negros Oriental, July and August, 1954; 18689, ½ km. S.W. of Palimpinon, Ocoy River Valley, Negros Oriental, August, 1954; 18605, 18681-85, 18690, 18752, Mayaposi environs and hills to the north and west of Mayaposi, about 20-30 km. west of Bais, Negros Oriental, January to March, 1955; 18727, Ilaya sitio, 3-4 km. south of Calilling, Negros Occidental, December, 1954; S.U. R-117-18, 242-44, 246, 251, 262, 267, 272-73, 275-78, Cuernos de Negros area, Negros Oriental; M.C.Z. 54254-6, low ridge north of Maite River, Cuernos de Negros, 3 to 7 km. west of Luzuriaga, Negros Oriental, 1954.

Diagnosis. Habitus rather slender; snout to vent length 62-95 mm. for 32 mature specimens; length of hind limb 16 to 22.5 per cent of snout-vent length for 28 mature specimens; postnasal long, in contact with the second supralabial in 37 of 45 specimens examined for this characteristic; 24-28 scale rows around the middle of the body for 49 specimens; 64-68 scale rows along the middorsal line between the parietals and the base of the tail for 49 specimens; dorsolateral light stripe not present; lower lateral surfaces and generally venter dark spotted.

Color (freshly preserved material). The dorsum and the upper lateral surfaces vary from light to dark brown, forming a pattern of dark and light, narrow, longitudinal stripes or nearly uniform. The lower lateral surfaces vary from near Rosetan to Blush or darker (Maerz and Paul, pl. 12), frequently with scattered to numerous small brown spots.

Range. Known from Negros Island and probably Mindoro.

Brachymeles schadenbergi Fischer

The Negros population exhibits constant differences in certain characteristics for a sufficiently large series of specimens to justify its recognition as a subspecies which is distinct from the typical one of Mindanao Island. The 3 available examples from Jolo and 2 specimens from the mountains of northern Luzon are close to the Negros population in the number of middorsal scale rows between the parietals and the base of the tail, and the presence of a more or less distinct, dorsolateral light stripe, and are tentatively referred to this subspecies. The single specimen from Palawan (C.A.S. 15571) lacks the light stripe and would

appear to agree most closely with the Mindanao population.

If larger samples do indeed prove the Luzon, Negros and Jolo populations to be the same from a taxonomic standpoint, and that of Palawan, Basilan, Mindanao, Leyte and Bohol to be taxonomically identical, this distributional pattern, which is not wholly in accordance with logical routes of dispersal in terms of what is known of the geological history of the archipelago, suggests three possible interpretations: (1) chance colonization of widely separated islands, across intervening sea barriers, by two distinct subspecies; (2) more or less isolated populations of a polytypic species exhibiting chance convergence with respect to the presence or absence of a dorsolateral stripe; (3) two population groups of sibling species, very similar morphologically, which have maintained disjunct distributions within this archipelago. The first interpretation is accepted with some reservations in this paper.

Brachymeles schadenbergi schadenbergi (Fischer)

Eumeces (*Riopa*) *schadenbergi* Fischer, 1885, Jahrb. wiss. Anst. Hamburg, **2**: 87 — Mindanao Island.

Material examined. Basilan Id. 15 (C.A.S. 60305-10, 60312, 60438-40, 60493-98); Mindanao Id. 7 (C.N.H.M. 22528-29, 52638-41, 61963-64); Leyte Id. 3 (N.H.M.S.U. 18701; C.N.H.M. 42779, 42792); Bohol Id. 5 (N.H.M.S.U. 18702-06); Palawan Id. 1 (C.A.S. 15571).

Diagnosis. A moderately large *Brachymeles* with rather well developed limbs; number of midbody scale rows 26-28 (mean = 26.5 ± 0.161 for 25 specimens); a light dorso-lateral stripe absent; the second pair of chin shields separated by three scales.

Color (freshly preserved material from Bohol Island). Dorsum and upper surface of limbs are blackish brown; lateral surfaces are near Melon, Baby rose, Crabapple, Burmese gold or Burnt orange (Maerz and Paul, pls. 2 and 3). The venter is whitish, lightly tinted with the above shades.

Range. Known from the Sulu Archipelago, Mindanao, Leyte and Bohol Islands (probably also Palawan Island).

Table 2
Comparison of subspecies of *Brachymeles schadenbergi*

	No. of midbody scale rows	Dorsal scale rows between parietals and base of tail	Dorso-lateral stripe present
B. s. schadenbergi (Mindanao and Basilan)	R = 26-28 M = 26.5 ± 0.161 N = 25	R = 67-71 M = 68.8 ± 0.250 N = 25	No
B. s. schadenbergi (Leyte)	R = 28 N = 3	R = 68,68,70 N = 3	No
B. s. schadenbergi (Bohol)	R = 28 N = 5	R = 70,71 (4) N = 5	No
B. s. schadenbergi (?) (Palawan)	R = 28 N = 1	R = 70 N = 1	No
B. s. talinis (Negros)	R = 28-32 M = 30.4 ± 0.276 N = 11	R = 67-70 M = 68.2 ± 0.193 N = 12	Yes
B. s. talinis (?) (Jolo)	R = 29,30,32 N = 3	R 72,72,73 N = 3	Yes
B. s. talinis (?) (Luzon)	R = 26,28 N = 2	R = 69,70 N = 2	Yes

R = range, M = mean, N = number of specimens

Brachymeles schadenbergi talinis subsp. nov.

Holotype. N.H.M.S.U. No. 18358, a female, collected by F. Empeso, December 14, 1954 on the low ridge north side of the Maite River, 5 to 6 km. west of Luzuriaga, Negros Oriental.

Paratypes. N.H.M.S.U. Nos. 12225 collected Dumaguete environs, Negros Oriental, 1940; 18359, low ridge north of the Maite River, Cuernos de Negros, about 5-6 km. west of Luzuriaga, Negros Oriental, Dec., 1954; 18363-64, 18366, high ridge north of the Maite River and on north slope of north peak of Cuernos de Negros, about 6-8 km. west of Luzuriaga, Negros Oriental, Dec., 1953, March, 1955; 18360-62, ridge south of the Maite

River, east slope of Cuernos de Negros, about 6-7 km. west of Luzuriaga, Negros Oriental, Nov., 1954, March, 1955; M.C.Z. 54257, high ridge north of Maite River, Cuernos de Negros, about 6-8 km. west of Luzuriaga, Negros Oriental; S.U. R-261, ridge south of the Maite River, east slope of Cuernos de Negros, about 6-7 km. west of Luzuriaga, Negros Oriental; C.N.H.M. 22527, Mt. Canlaon, Negros Oriental.

Diagnosis. A large *Brachymeles* with rather well developed limbs, differing from the typical subspecies in the generally greater number of midbody scale rows 28-32 (mean = 30.4 ± 0.670 for 11 specimens); a moderately wide (two and two half scale rows at the shoulder), dorso-lateral light stripe, reddish in life, sometimes fading in older specimens; second pair of chin shields generally wider, separated by 1 scale in 8 specimens, 2 in 1 specimen and 3 in 2 specimens as compared to 3 in a sample of 23 specimens of the nominate subspecies examined for this character.

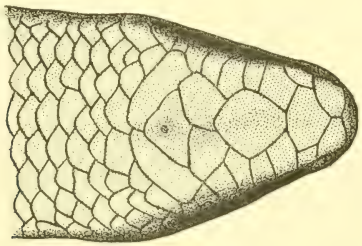

Fig. 3. Dorsal view of head of *Brachymeles schadenbergi talinis.*

Color (freshly preserved material). Dorsum is dark reddish brown, the lateral margins of the scales tending to be dull reddish producing an indistinct, lined pattern. This dorsal brown band is rather uniformly six and two half scale rows in width and is bordered on either side by a dull red stripe one and two half rows in width. (These fade to white or whitish tan in preservative.) These stripes begin just posterior to the eye and extend to the region of the hind limbs or the base of the tail.

They are most uniform and conspicuous in juveniles, tending to become somewhat paler and irregular, especially on the posterior part of the body for some adults. The red stripes are bordered ventrally by one to three or four rows of brownish or brown spotted scales. Lower lateral surfaces grayish white to light tan, frequently diffused with orange-yellow and with scattered brown spots especially in the midventral line and the region of the hind limbs. The labials are brownish; mental, rostral, nasals, supranasals and postnasals grayish.

Range. Known definitely at the present time from Negros Island (probably also Luzon and Jolo Islands, see p. 14)

The name *talinis* in the native dialect refers to mountains such as Cuernos de Negros which this subspecies inhabits.

ACKNOWLEDGMENTS

I am greatly indebted to Dr. Jean Guibé, Muséum National d'Histoire Naturelle, Paris, and Mr. Arthur Loveridge, Museum of Comparative Zoology, Harvard University, and Mr. J. C. Battersby, British Museum (Natural History) for their kindly assistance in re-examining the types of *Brachymeles bonitae, Brachymeles wrighti, Brachymeles pathfinderi* and *Brachymeles bicolor;* to Dr. Robert F. Inger, Chicago Natural History Museum and Dr. Joseph R. Slevin, California Academy of Sciences for permitting me to examine material of this genus in the collections of their respective institutions. I also wish to thank Dr. Inger for his kindness in suggesting that I describe at this time a new species from Samar Island which is represented by a unique specimen in the collections of the Chicago Natural History Museum.

This study was begun while the author was serving as a Fulbright lecturer at Silliman University, in the Philippine Islands, under the auspices of the United States Educational Foundation, and it was completed while working as a research associate at Stanford University supported by a grant from the National Science Foundation. Illustrations were prepared by Mr. Walter Zawojski, Stanford Research Institute.

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BREVIORA

Museum of Comparative Zoology

CAMBRIDGE, MASS. JUNE 6, 1956 NUMBER 55

REDISCOVERY OF *HYLA DORSALIS* AND *LECHRIODUS PAPUANUS* IN NEW GUINEA

BY ARTHUR LOVERIDGE

Last year I had occasion to describe a new microhylid discovered by Mr. Kenneth R. Slater at Omati, Papua. More recently we have received part of a collection made by Mr. Slater during a trip up the Aramia River. This river lies somewhat to the north of Katow (i.e. Binturi River, Papua), a locality from which Macleay (1877, Proc. Linn. Soc. New South Wales, **2**, pp. 135-138) described a number of amphibians, among them *Litoria dorsalis* Macleay, now known as:

HYLA DORSALIS (Macleay)

This hylid, so far as I know, has not been taken again during the period of almost eighty years that has since elapsed. Among the Slater material is a 20 mm. gravid ♀ *Hyla* (M.C.Z. 28389) that agrees so closely with Macleay's brief description of the holotype of *dorsalis* (whose length is given as "9 lines," i.e. 19 mm., its hind limb as "16 lines," i.e. 33.8 mm. as against 35 mm. in ours) that I have no hesitation in assigning our frog to *dorsalis*, which must be one of the smallest members of the genus *Hyla*.

Slater's specimen differs only in the absence of a light vertebral line from snout to anus. On either eyelid are two tiny tubercles that, if constant in the species, may well have been overlooked by Macleay.

Lechriodus papuanus (Roux)

The same collection contained half a dozen frogs (M.C.Z. 28382-7) bearing a distinct resemblance to *Cornufer*, but I am indebted to Dr. L. D. Brongersma of Leiden for pointing out that they have arciferal shoulder girdles and more or less dilated sacral diapophyses, so that he would refer them to *Lechriodus papuanus* (Roux) which was described in 1927 from a single juvenile ♀, 23 mm. in length, taken near Lake Sentani on the northern coast of Netherlands New Guinea. In the thirty years that have intervened since the holotype was taken by Dr. P. Wirz, no second specimen has been recorded so far as I know.

No material was available to Parker when he monographed the Leptodactylidae of Australasia (1940, Novit. Zool., **42**, pp. 1-106) and he had but two examples of *L. fletcheri* (Boulenger) of which Roux made *papuanus* a subspecies. Parker (pp. 25, 27) treated *papuanus* as a full species but the dermal skinfolds by which he separates the two forms are so highly variable that it is questionable if they really do so. If Brongersma and I are correct in assigning these frogs to *papuanus*, the ⌒-shaped interorbital fold figured by Roux is either irregularly transverse, more often ⌣-shaped; the "curved, convergent dorso-lateral folds" are often rather ill-defined and may be represented by a few odd plicae extending no further than the scapula region. In only one frog do they approach the distinctness suggested by Roux's figure; they are quite indistinguishable from our *fletcheri* ♀ ♀ from New South Wales in this respect. As I find little but color to separate the two, it would seem that Roux was justified in regarding *papuanus* as only a race of *fletcheri*.

If I were called upon to distinguish the two forms I would do so as follows:

Color above pale brown with traces of a blackish brown line from end of snout along the canthus to the eye and from eye over tympanum to a point above elbow; lower lip dark brown; no interorbital skin fold (on either of our ♀ ♀ from New South Wales). *Range:* New South Wales; Queensland; and (*fide* Parker) British New Guinea . . . . . *f. fletcheri*

Color above light gray, a white, finely black-edged, shieldlike patch on snout which may merge with two similar, but smaller, anteorbital patches; from eye over tympanum to a

point above elbow a broad or narrow blackish brown line which may break up into a series of black specks; lower lip white; an indistinct interorbital skin fold (4 ♂♂, 2 ♀♀ from Aramia River). *Range:* British and Dutch New Guinea . . . . *f. papuanus*

Our knowledge of *f. papuanus*, hitherto derived from a single immature ♀, is naturally extended by the Aramia River series of adult ♂♂ and ♀♀; on the latter the following description is exclusively based.

Description. Vomerine teeth in two confluent or semiconfluent series extending in an almost unbroken undulating line right across the roof of the mouth behind the level of, and beyond, the choanae. Head slightly broader than long, i.e. the breadth equals the distance from end of snout to angle of jaw; snout oval to obtusely rounded; nostril slightly nearer the front of the lip than it is to the orbit; interorbital space narrower than an upper eyelid; upper eyelid with several small, sometimes scarcely noticeable, tubercles; a rather indistinct, transverse or ⌣-shaped interorbital fold; from the eye a supratympanic fold, which may be broken up, extends posteriorly to a point above the shoulder; tympanum vertically oval, its horizontal diameter about two-thirds that of the eye; from behind the eyelids a pair of more or less)(-shaped glandular skin folds (frequently reduced to a pair of short lines) extend to, or beyond, the scapular region of the otherwise largely smooth dorsum.

Fingers free, their tips somewhat swollen but not dilated, without horizontal grooves, first and second subequal in all six specimens; subarticular tubercles large, metacarpus with a large supernumerary tubercle; toes webbed, from first to fifth the following phalanges free (except for a lateral seam) 2, 2, 3, 4, 2½, their tips slightly dilated and with or without a circummarginal groove, third toe longer than the fifth; subarticular tubercles prominent, a conspicuous inner metatarsal two-thirds the length of the first toe, no outer metatarsal tubercle; tibiotarsal articulation of an adpressed hindlimb extends almost to the nostril, or to the nostril, or end of snout. Skin of throat and belly smooth.

Color. Above, tip of snout with a conspicuous white, finely black-edged, shieldlike patch that may be disconnected with a similarly light patch in front of each eye, or fork posteriorly and merge with the anteorbital patches; from eye towards flank a more or less conspicuous black line which breaks up into black flecks on the flank immediately posterior to the forearm; dorsum pale gray, with or without a few fine black lines; supra-anal area pale; circum-anal area black, becoming lighter on the buttocks toward the tibio-tarsal joint; fore- and hindlimb more or less faintly crossbarred. Below, white, uniform except that the chin and jaws are grayish in ♂ ♂, while in both sexes the lower posterior aspect of forearms, anterior aspect of tibia, and soles of feet, are black.

Size. Length from snout to anus of largest ♂ (M.C.Z. 28385), 49 mm., of ♀ (M.C.Z. 28382), 52 mm.; length of head from tip of snout to back of tympanum in ♂, 18 mm.; in ♀, 20 mm.; length of hind limb from anus to tip of longest toe in ♂, 77 mm.; in ♀, 86 mm. In size, therefore, *papuanus* differs little from *fletcheri.*

Stomach contents. That of the ♂ was found by my colleague Dr. W. L. Brown to consist of a chrysomelid beetle, a termite's head, and remains of ants referable to the genus *Odontomachus.*

BREVIORA

Museum of Comparative Zoology

CAMBRIDGE, MASS. JUNE 15, 1956 NUMBER 56

NOTES ON THE JAMAICAN AND CAYMAN ISLAND LIZARDS OF THE GENUS *CELESTUS*

BY PENNY NORSEEN COUSENS

The collections of the Museum of Comparative Zoology afford a representative sample of the Celesti of Jamaica and the Cayman Islands[1] and, additionally, include types of 5 of the 8 forms recognized in the last revisions of Chapman Grant (1940b and c). Renewed examination of this material has confirmed the distinctness of certain forms but has placed in question the status of certain others. It is hoped to return to the study of this genus in these and other islands in the future but as an aid to students of this difficult group it has been thought desirable to place on record at this time the new conclusions as to the status of the Jamaican and Cayman forms.

The characters studied were: habitus; color pattern; dorsal, ventral and midbody scale counts, numbers of chin shields, and number of subdigital lamellae on the fourth digit; general body measurements; presence or absence of a keel and number of striae on dorsal scales. Head scalation was checked but not recorded on at least one individual of each species. No internal characters were used. It was impossible to sex the specimens except in the case of females carrying young, but it is doubtful if there is any sexual dimorphism in the species studied.

Only four species appear to be valid, as follows:

1 One species, the giant form *Celestus occiduus* Shaw, is unrepresented. However, omission of this species from the present discussion appears to be justified in as much as its right to consideration as a still surviving form is very improbable. It has not been collected in over 100 years. Grant's suggestion that *hewardii* is a subspecies of this form cannot be seriously regarded.

Key to the Jamaican and Cayman forms of Celestus:

1. Adpressed limbs meet or fail to meet by less than length of forearm. Dorsal color pattern consisting of broken bars or rings 2
   Adpressed limbs fail to meet by greater than length of forearm. Dorsal color pattern not ringed 3

2. 19 or fewer subdigital lamellae on fourth toe of hind foot. Throat mottled ..... *hewardii* Gray 1845
   Range: Central and western Jamaica and Portland Point.
   21 or more subdigital lamellae on fourth toe of hind foot. Throat not mottled ..... *duquesneyi* Grant 1940a
   Range: Portland Point only.

3. 89-116 dorsal scales, occipital to point above vent 4
   125-139 dorsal scales, occipital to point above vent ..... *barbouri* Grant 1940b
   Range: known only from Mandeville in south central Jamaica and Fern Gulley in north central Jamaica.

4. Tail dorsally with the same color and pattern as back ..... *crusculus crusculus* Garman 1187
   Range: all of Jamaica, at least in the lowlands.
   Tail dorsally lighter than back and without pattern ..... *crusculus maculatus* Garman 1888
   Range: Cayman Brac and Little Cayman.

DISCUSSION

As the key indicates, and as Grant (1940b) has previously emphasized, the four species fall into two groups — one long-legged, the other short-legged. This may be a quite natural grouping, in these islands at least.

In the long-legged group the two species, although similar in general body proportions, differ in several characters. The relatively widespread *C. hewardii* is a stockier, blunt-snouted lizard, its dorsum with dark brown broken bars on a light brown background, its throat mottled, 12-19 lamellae on fourth toe, 4 pairs of chin-shields. *C. duquesneyi*, confined to Portland Ridge, is a more slender lizard with a pointed snout, its dorsal pattern similar to *hewardii* but lighter (specimens collected in same year), background tan with light brown bars, the throat immaculate, 21-22 lamellae on fourth toe, 5-7 pairs of chin-shields. Unquestionably *C. duquesneyi* is a distinct species. M.C.Z. 45181 from Portland

Ridge was misidentified as *hewardii* but proved easily separable from a *hewardii* with the same locality data despite the loss in 45181 of the blue tail so much stressed by Grant as diagnostic for *duquesneyi*.

In the second, short-legged group the series of *C. barbouri* studied included the type and 13 specimens collected by Barbour,[1] all from Mandeville, plus a single specimen from Fern Gulley. One character, dorsal scale count, readily separates *C. barbouri* from *C. crusculus*.[2] This difference is very marked and shows no overlap. *Crusculus* has the lowest dorsal scale count of any Jamaican *Celestus* (mean 101.52, range 89-116); *barbouri* has the highest (mean 132.27, range 127-139). At Mandeville, where the two species are sympatric, *crusculus* shows a very low mean of 97.64 (range 96-101) and also the strongest divergence of color pattern. The dorsal pattern of *barbouri* consists of a series of dark brown chevrons with the V's pointing caudad. *Crusculus* shows a variety of patterns: plain tan dorsum with dark brown lateral bands extending the length of the body; a checkerboard dorsal pattern; checkerboard blending into chevrons; chevrons with lateral bands; chevrons only, this pattern almost indistinguishable from *barbouri* in several specimens. At Mandeville, the last type does not occur and the chevrons-with-lateral-stripes pattern occurs only once. These pattern types were established to aid in grouping specimens — gradations and modifications are common.[3]

C. crusculus is a variable species also in dorsal, ventral, and midbody scale counts. There is, however, no correlation between scale counts and pattern, and the two Jamaican subspecies proposed by Grant (1940a) on such supposed correlations are therefore here regarded as invalid, *C.c. cundalli* with the type locality Mandeville being untenable on any ground. The Mandeville population cannot be distinguished from that at Kingston, the

1 These were labeled by him as *impressus* Cope. The status of this name is very much in doubt and its disposition will depend on a new evaluation of the types in the Philadelphia Academy.

2 Ventral scale counts are, as usual, fully parallel to dorsal scale counts and not really an independent variable.

3 Another color difference has been pointed out to me by Garth Underwood. The side of the neck in *barbouri* bears rather large pearly spots as compared with smaller punctations in *crusculus*.

type locality of *crusculus*. *C.c. molesworthi* is more nearly justifiable. Specimens from the area ascribed to this latter subspecies, Boston Bay, Ecclesdown and Buff Bay in northeastern Jamaica, show exceptionally high dorsal counts. However a total of five localities shows a count higher than the average for the species as a whole: Boston Bay (mean 109.4) and Ecclesdown (mean 106.5), on the fringe of the tropical rain forest on the eastern side of the island which may act as an isolate; Balaclava (mean 110.5), about 15 miles northwest of Mandeville; Bogwalk and Mona, close to Kingston. The coefficients of difference (C.D.) were calculated for Ecclesdown-Boston Bay and Balaclava compared to both Mandeville and the species as a whole:

	Boston Bay-Ecclesdown	Balaclava
Mandeville	C.D. = 1.57	C.D. = 2.32
entire species	C.D. = .676	C.D. = 1.01

As is to be expected, as compared to the entire species, the C.D. is not significant. The Ecclesdown-Boston Bay and Balaclava populations are sufficiently different from the Mandeville population as determined by the C.D. that in the opinion of some they might well be considered subspecies. Subspecific rank has not been accepted for these populations for two reasons: the samples are so small that there is no probability that the sample mean equals the population mean; furthermore, considered for the Jamaican populations as a whole the distribution of high or low dorsal counts seem to be random. The midbody scale counts are also higher in the northeast populations, but again samples are small, and high and low mean counts are merely the extremes of a cline in which there is overlap between even the southeast and northeast populations.

Celestus maculatus of Cayman Brac and Little Cayman, retained by Chapman Grant as a full species, does not differ from *C. crusculus* in scale counts or measurements but does differ in one detail of color — the coloring of the dorsal side of the tail. In *C. maculatus* the tail is light tan or ivory in alcohol and so without pattern; in *C. crusculus* of Jamaica the dorsal color and pattern are continued on to the tail. In other respects the coloration of *C. maculatus* falls within the range of Jamaican *crusculus*, and its low scale counts resemble the Mandeville population of the latter. The Cayman population must be regarded as con-

specific with Jamaican populations but because of the tail color difference it may be recognized as a distinct subspecies, *C. crusculus maculatus*.

SUMMARY

1. Four species of *Celestus* occur on Jamaica.

2. They may be arranged in two groups: the *hewardii* group (long-legged group) made up of *C. hewardii* and *C. duquesneyi*, and the *crusculus* group (short-legged group) comprising *C. crusculus* and *C. barbouri*.

3. *C. hewardii*, *C. crusculus* and *C. barbouri* are sympatric at Mandeville.

4. *C. hewardii* and *C. duquesneyi* (sympatric at Portland Ridge) can be distinguished by habitus, coloration, lamellar count and number of chin shields.

5. *C. barbouri* and *C. crusculus* can be distinguished by dorsal scale count.

6. *C. crusculus* is extremely variable and composed of two subspecies: *C. crusculus crusculus* occurring on Jamaica and *C. crusculus maculatus* occurring on Cayman Brac and Little Cayman. There may be a third subspecies *C. crusculus molesworthi*, distinguishable by high dorsal scale counts and found in northeastern Jamaica. Its validity is, however, not yet firmly demonstrated.

I wish to express my thanks to Dr. Ernst Mayr and Dr. E. E. Williams for their generous and valuable advice, to Mr. Benjamin Shreve who made the scale counts and measurements on the specimen of *Celestus barbouri* from Fern Gulley, and to Mr. Garth Underwood for useful criticism of the manuscript.

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BREVIORA

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THREE NEW SPECIES OF MIMETIDAE (ARANEAE) FROM PANAMA

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In 1947 I published a brief paper attempting to bring our knowledge of the Mimetidae of Panama up to date. At that time six species of *Gelanor* were recognized and two of these were regarded as new. Five species of *Mimetus* were also recognized at that time and two were considered new to science. As a result of two field trips into various parts of Panama since 1947 (1950 and 1954) a considerable number of specimens belonging to this family have been sorted from my collections. Three new species belonging to the two genera mentioned above have been selected from these later collections. These are described in this paper in accord with my usual procedure. I regret that I cannot yet be more certain regarding the correct association of males and females in several of the known species. The types are being deposited in the Museum of Comparative Zoology.

It is again a pleasure to acknowledge my indebtedness to the following persons for their continued encouragement in the pursuit of my studies: Dr. A. S. Romer and Dr. P. J. Darlington, Jr., Director and Curator of Insects, respectively, in the Museum of Comparative Zoology at Harvard College. Without the privileges which have been extended to me for many years in this institution the continued progress of my studies would have been much more difficult.

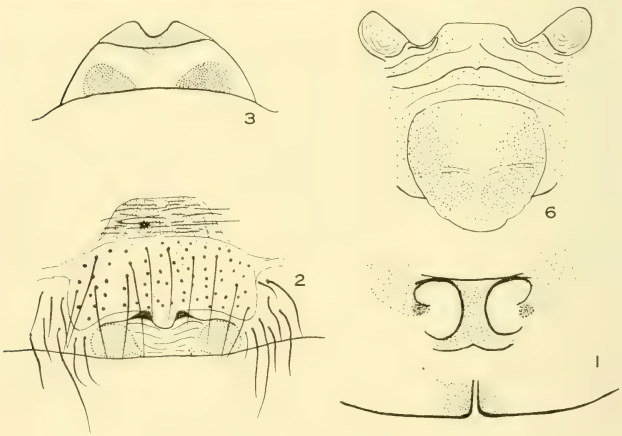
Genus GELANOR Thorell, 1870

GELANOR DEPRESSUS sp. nov.

(Fig. 1)

Female holotype. Total length 4.16 mm. Carapace 2.145 mm. long; 1.69 mm. wide opposite second coxae where it is widest; narrowed to .91 mm. just behind PLE; about 1.04 mm. tall opposite first coxae where it is tallest; rises gradually from PE to highest point, then descends fairly steeply to posterior border; with median thoracic pit about midway of the posterior declivity.

Eyes. Eight in two rows as usual; heterogeneous; lateral eyes on a moderately prominent tubercle. AME separated from one another by slightly more than their diameter, from ALE by 9/7 of their diameter. PME separated from one another by about 7/10 of their diameter, from PLE by 2.6 times their diameter. Laterals contiguous to one another. Seen from above, anterior



External Anatomy of *Gelanor* and *Mimetus*

Fig. 1. *Gelanor depressus* sp. nov.; epigynum, ventral view.

Figs. 2-3. *Mimetus saetosus* sp. nov.; epigynum, ventral and posterior views respectively.

Fig. 6. *Mimetus variegatus* sp. nov.; epigynum, ventral view.

row quite strongly recurved, posterior row gently procurved. Seen from in front, anterior row gently recurved, measured by centers. Central ocular quadrangle wider in front than long in ratio of 13 : 11, wider in front than behind in ratio of 3 : 2. Height of clypeus equal to 9/14 of the diameter of AME. Ratio of eyes AME : ALE : PME : PLE = 14 : 9 : 11 : 10 (long diameters used when differences exist).

Chelicerae. Vertical, parallel, somewhat narrowed at their bases; bases united for about one fifth of their length; basal segment .975 mm. long; with several long slender spines but none notably enlarged; basal boss lacking. Fang groove with the usual row of six or seven stiff spines but with no visible teeth; retromargin with a single low tuberculate tooth near middle.

Maxillae. Convergent; moderately slender; almost contiguous distal to lip; palp inserted into basal third.

Lip. Clearly united to sternum with no sternal suture visible; only slightly longer than wide near middle.

Sternum. Scutiform in general; moderately convex; widest between first coxae but nearly as wide between second coxae; longer than wide in ratio of about 11 : 8; with numerous long slender bristles; posterior end extended between fourth coxae and terminating in a sharp point; with fourth coxae separated by a little less than the width of one of them; first and second coxae robust, third and fourth slender.

Legs. 1243. Width of first patella at "knee" .352 mm., tibial index of first leg 7. Width of fourth patella at "knee" .22 mm., tibial index of fourth leg 9.

(All measurements in millimeters)

	Femora	Patellae	Tibiae	Metatarsi	Tarsi	Totals
1.	3.770	1.235	3.510	3.640	2.015	14.170
2.	3.510	1.100	2.600	2.510	1.430	11.150
3.	1.950	.660	1.690	1.690	.750	6.740
4.	2.405	.700	1.700	1.755	.750	7.310

Spines. First leg: femur dorsal 0-1-1, prolateral and retrolateral only one near distal end, ventral 0; patella 0; tibia only with definite spines on prolateral surface as follows: a series of

seven robust spines beginning near proximal end and extending to near distal end and with seven series of shorter spines following the robust spines and distributed as follows: 2,3,3,3,4,4,5; metatarsus with only definite prolateral spines as follows: a series of four robust spines beginning at proximal end and with fourth near middle and four series of shorter spines following the robust spines and distributed as follows: 5,7,8,19. Second leg: femur and patella as in first except femur dorsal 1-1-1; tibia only with definite spines as follows on prolateral surface: with five robust spines, the first weaker and near proximal end, the fifth about one fifth from distal end and with shorter spines following the robust spines arranged as follows: 0,1,4,4,5; metatarsus also only with definite spines as follows: on prolateral surface one moderately long and robust proximal spine and near this there is a very long and robust spine with another similar spine about one fourth of the length of the segment from the base; immediately following the first long robust spine there is a series of six shorter curved spines, and following the second long spine there is a series of 18-20 shorter curved spines diminishing to mere bristles distally. Third leg: femur only dorsal 0-1-0; patella only one dorsal distal spine, long and slender; tibia only dorsal distal 1 and prolateral 0-1-0; metatarsus only dorsal distal 1 (very slender) and prolateral 0-1-0-0-0. Fourth leg: femur 0; patella as in third; tibia only dorsal 0-1-0-1-0; metatarsus apparently only prolateral 0-1-0-0-0. Palp: femur apparently only with a pair of dorsal distal spines; patella with a single long slender dorsal distal spine; tibia with a group of three or four distal spines, lacking ventrally; tarsus dorsal 0-1-0-0-0, prolateral and retrolateral 0-1-1-0. Palpal claw with one short and one long tooth. Tarsal claws three with spurious claws as usual. The "drum" has been seen on the dorsal side of some tarsi about one fourth of the length of the segment from the distal end.

Abdomen. Moderately high, well rounded laterally; slightly broader than long near middle. Anal tubercle and spinnerets as usual in the genus. Colulus well defined. Tracheal spiracle well defined and just anterior to base of colulus. Genital groove well defined just posterior to epigynum.

Epigynum. Quite tuberculate; posterior surface with a pair of chitinized areas separated by a shallow slit; ventral surface

with a pair of moderately deep depressions separated by a septum (Fig. 1).

Color in alcohol. Legs: third and fourth pairs nearly unicolorous yellowish; first pair darker yellowish with femora reddish dorsally and patellae also somewhat reddish especially at proximal ends and tibiae reddish at distal ends. Chelicerae a clear yellowish with fangs brownish. Lip and maxillae yellowish with reddish streaks. Carapace yellowish with reddish flecks just behind PE and a pair of irregular spots near apex and two pairs of irregular reddish spots further posterior. Sternum generally yellowish but with a small reddish dot opposite each second coxa and a large irregular spot covering most of the posterior half. Abdomen: anterior third of dorsum yellowish with a few bright red flecks at the base; about one third from the base are two irregular bright red spots, each with two small white dots nearly enclosed by the red color; behind these spots there is a series of nine or ten very narrow red transverse lines; the venter is yellowish lateral to the epigynum but reddish centrally behind this organ and with numerous oblique red ventro-lateral lines.

Type locality. Female holotype is from Barro Colorado Island, C. Z., June, 1950. There are no paratypes.

Genus MIMETUS Hentz, 1832

MIMETUS SAETOSUS sp. nov.

(Figs. 2-3)

Female holotype. Total length 3.71 mm. Carapace 1.95 mm. long; 1.43 mm. wide between third coxae where it is widest; narrowed to .845 mm. just behind PLE; with no longitudinal thoracic groove but with a shallow depression about midway along the posterior declivity; rises slightly from PLE to opposite interval between first and second coxae and then after a gentle arch descends steeply to posterior border; with twelve spines in three rows behind PE, the middle row of only two and with each lateral row with five, the posterior one on each side being offset laterally.

Eyes. Eight in two rows; heterogeneous; LE on prominent tubercles; AME at base of a tubercle which extends considerably

dorsal from the eye level, with a spine at tip of each cone as in *M. rusticus* Chickering. AME separated from one another by two thirds of their diameter, from ALE by 1.3 times their diameter. PME separated from one another by slightly more than their radius, from PLE by nearly 2.2 times their diameter (long diameters used when eyes are not circular). Laterals separated only by a line.

Chelicerae. Vertical, parallel, quite robust, quite convex in front; basal segments united at bases for about one fourth their length which is .88 mm.; without basal boss; with numerous short slender bristles in front and several longer ones; with one fairly robust spine in medial position near distal end overlapping its mate on opposite side. Fang as usual in the genus. Retromargin of fang groove with a single tuberculate tooth near medial end; promargin with a row of ten robust spines.

Maxillae. Slender, slightly convergent; palp inserted near base; serrula extends only along outer distal corner.

Lip. Wider than long in ratio of about 5 : 4; reaches well beyond middle of maxillae; no definite suture observed.

Sternum. Scutiform; longer than wide in ratio of 13 : 16; widest between first coxae; slightly convex; with numerous long slender bristles; posterior end rounded, not extended between fourth coxae which are separated by about two thirds of their width. First coxae considerably swollen; third coxae the smallest.

Legs. 1243. Width of first patella at "knee" .286 mm., tibial index of first leg 8. Width of fourth patella at "knee" .198 mm., tibial index of fourth leg 9.

(All measurements in millimeters)

	Femora	Patellae	Tibiae	Metatarsi	Tarsi	Totals
1.	2.860	.780	2.730	2.275	1.250	9.895
2.	2.340	.650	1.950	1.820	1.105	7.865
3.	1.300	.455	1.040	.855	.840	4.490
4.	1.820	.528	1.690	1.235	.845	6.118

Spines. First leg: femur dorsal 0-1-1-1-1-1-0 with irregularities in placement, prolateral 0-0-1-1-1, retrolateral only one robust spine near distal end but with a somewhat oblique row of about

a dozen short stiff spinules in the proximal fifth, ventral a nearly median row of about fourteen long slender spines together with another row of similar but less regular spines in a prolateral position; patella only dorsal spines 1-1 together with several very slender spines irregularly placed; tibia dorsal 0-1-1-1-0, prolateral robust spines 0-1-1-1-1-1-1-1-0 together with short spines between the robust spines and distal to the last in numerical series as follows: 3-2-4-3-4-4-5, retrolateral robust spines 0-1-0 together with numerous long slender spines, ventral with only numerous long slender spines; metatarsus dorsal only a series of long slender spinules, prolateral robust spines 1-1-1-1-1-1-0 with the expected short curled spines intervening between the robust spines and distal to the last of these in six series distributed as follows: 3-4-5-6-7-9, retrolateral with a row of 9 long slender spines, ventral with another row of long slender spinules, hardly more than bristles. Second leg: femur essentially as in first except for the presence of the proximal prolateral row of short stiff spinules presumably used in opposition to the retrolateral row of similar spinules on the first femur; patella as in first; tibia dorsal 0-1-1-1-0 plus several long slender spines somewhat irregularly placed, prolateral 0-1-1-1-1-1-0 plus smaller spines between robust spines and distal to the last of these but these are less numerous and less conspicuous than in first, retrolateral and ventral as in first; metatarsus dorsal as in first, prolateral robust spines 1-1-1-1-0 with shorter spines terminally bent in four series distributed as follows: 3, 4, 6, and 11. Third leg: femur essentially as in first; patella as in first; tibia dorsal 0-1p-0-0, prolateral 0-1-0-0, retrolateral 0-1-0, ventral 0-1p-0-1p-0; metatarsus dorsal 0, prolateral 0-1-0-0, retrolateral 0-1-0, ventral 0-2(irregular)-0. Fourth leg: femur and patella essentially as in first; tibia dorsal 0-1r-0-1-0, prolateral 0-1-0-0, retrolateral 0-1-0 together with several other slender spines irregularly placed, ventral 0-1p-0-1-0 together with several long slender and weak spines irregularly placed; metatarsus essentially as in third. Palpal claw pectinate with a single row of 5 or 6 slender teeth in proximal half.

Abdomen. 2.08 mm. long; 2.34 mm. wide between "shoulder humps" which are conspicuously developed. With numerous long slender stiff bristles, almost spines. Colulus well developed; tracheal spiracle a short distance anterior to base of anterior

spinnerets and with a fairly well developed chitinous lip. Spinnerets as usual in the genus.

Epigynum. With a moderately well chitinized plate; moderately protuberant; somewhat broader than long; with a narrow notched lip along posterior border (Figs. 2-3).

Color in alcohol. Legs and palps yellowish with many reddish brown spots and irregular rings. Chelicerae a rich reddish brown. Carapace in general yellowish with brownish markings; the largest of these begins at the clypeus and extends backward and narrows irregularly to a blunt point near the posterior border; three small irregular brownish spots occur on each lateral side. Sternum: with three pairs of small brownish spots and a single similar median spot at the posterior end. Abdomen: yellowish with many small brownish spots.

Type locality. Female holotype from Barro Colorado Island, C. Z., July 18, 1954. No paratypes.

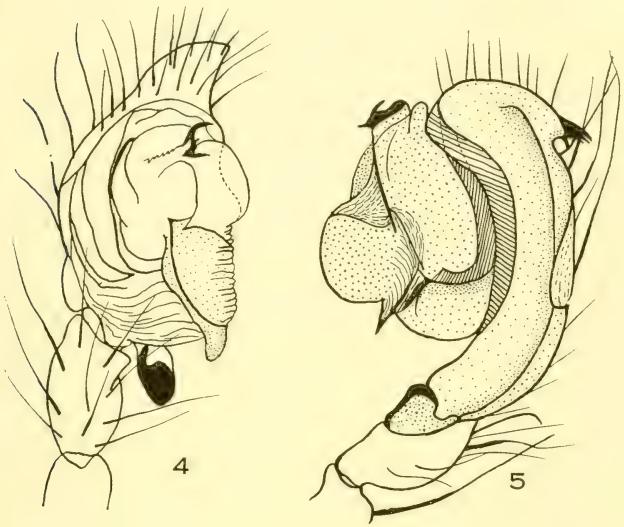
Mimetus variegatus sp. nov.

(Figs. 4-6)

Male holotype. Total length 2.795 mm. Carapace 1.3 mm. long; 1.17 mm. wide opposite interval between second and third coxae where it is widest; narrowed to .58 mm. wide just behind PLE; with no longitudinal median thoracic groove but with a broad shallow depression about midway along the posterior declivity; rises slightly from PE to opposite interval between second and third coxae and then descends steeply to posterior border; apparently with twelve slender spines in three rows on cephalic area posterior to PE.

Eyes. Eight in two rows; heterogeneous; all except PME on prominent tubercles. AME separated from one another by nearly 1.5 times their diameter, from ALE by about one third as much. PME separated from one another by their radius, from PLE by their diameter. Laterals separated from one another by a line. Seen from above, posterior row slightly procurved; seen from in front, anterior row slightly procurved. Central ocular quadrangle wider in front than behind in ratio of about 4 : 3, slightly wider in front than long. Ratio of eyes AME : ALE : PME :

PLE = 5.5 : 4 : 4.5 : 4.5. Height of clypeus equal to about 14/11 of the diameter of AME.



External Anatomy of *Mimetus*

Figs. 4-5. *Mimetus variegatus* sp. nov.; tibia and tarsus of male palp; two views.

Chelicerae. Vertical and parallel; rather long and slender; basal segment .65 mm. long; united at their bases for about one sixth of their length; without basal boss; with two slender spines on front surface and one more robust spine in medial position near distal end overlapping its mate on opposite side. Fang stout at base, strongly bent at middle, slender in distal half. Fang groove moderately distinct and without ordinary teeth but promargin has a row of 7 or 8 stout spinules (examination made on a paratype to avoid injury to the holotype).

Maxillae. Slender, somewhat convergent; reach considerably beyond lip; with palp inserted into base; with serrula only at outer distal corner.

Lip. About nine tenths as long as wide; with a well developed sternal suture; reaches well beyond middle of maxillae.

Sternum. Broad, scutiform; almost as wide as long; strongly convex; widest between second coxae but nearly as wide between first coxae; with a moderate supply of long slender bristles; posterior end rounded and not extended between fourth coxae which are separated by about 7/10 of the width of one of them; first coxae most robust; third and fourth nearly equal in size.

Legs. 1243. Width of first patella at "knee" .198 mm., tibial index of first leg 5. Width of fourth patella at "knee" .132 mm., tibial index of fourth leg 7.

(All measurements in millimeters)

	Femora	Patellae	Tibiae	Metatarsi	Tarsi	Totals
1.	2.990	.682	3.055	3.510	1.365	11.602
2.	2.405	.520	2.112	2.275	1.000	8.312
3.	1.625	.300	.975	1.034	.616	4.550
4.	1.820	.390	1.430	1.430	.616	5.686
Palp	.682	.198	.264	——	.682	1.826

Spines. First leg: femur dorsal 1-1-1-1-1, prolateral 0-1-1-1-0, retrolateral a row of short, somewhat robust spines extending through about three fifths of the length of the segment beginning at proximal end, together with a single long spine near distal end, ventral with several stiff bristles but hardly spines; patella dorsal 1-1; tibia dorsal 0-1-1-1-0 plus several weak spines hardly more than bristles between the robust spines, prolateral 0-1-1-1-1-1-1-0, retrolateral 0-0-1-0, ventral 0; metatarsus dorsal nine in the proximal four fifths of varied size and length, prolateral 1-1-1-1-1-0-0 with a few small intervening spines among the robust spines (in contrast to the expected condition), retrolateral with numerous weak spines but none robust of the usual sort, ventral 0. Second leg: femur dorsal as in first, prolateral devoid of long robust spines but with a row of very short stiff spinules extending through proximal third of segment and probably used in opposition to the similar spinules on the retrolateral surface

of first femur, retrolateral apparently with only one near distal end, ventral 0; patella essentially as in first; tibia dorsal 0-1-1-1-0 with several weak spinules and bristles irregularly distributed among the more robust spines, prolateral 0-1-1-1-1-1-0 with some irregularity together with spinules irregularly distributed among the more robust spines, retrolateral 0-0-1-0-1(weak), ventral 0; metatarsus dorsal 0, prolateral 1-1-1-0-0 with short spinules between the robust spines and distal to the last, retrolateral with a series of 10-12 spines of diminishing lengths toward the distal end where there are only bristles. Third leg: femur dorsal apparently 1-1-1-1-1 but with numerous spinules, elsewhere 0; patella only dorsal 0-1, tibia dorsal 0-1-0-0, prolateral the same, retrolateral 1(weak)-1-0, ventral 1p-1p-0; metatarsus dorsal 0-1-0-0, prolateral essentially the same, elsewhere 0. Fourth leg: femur and patella essentially as in third; tibia dorsal 0-1-0-1-0, prolateral and retrolateral 0-1-0, ventral 0; metatarsus only dorsal 0-1-0-0 with prolateral essentially the same. A comparison of the spines, especially on legs one and two, shows that they differ from those regarded as typical of the genus especially because of the great reduction of the number, size, and regularity of occurrence of the small spines in between the larger ones of tibiae and metatarsi. Palp: femur with only one dorsal distal spine; patella with two long slender dorsal spines; tibia with a row of five or six long slender spines or spinules curving along near distal border.

Palp. Of moderate length; tibia and patella short; tarsus moderately complicated; with structural features best shown in Figures 4-5. Base of cymbium with a lobule which suggests that of *M. verecundus* Chickering but is, nevertheless, quite distinct from that species.

Abdomen. Of moderate height; about 9/11 as wide as long at level of "shoulder humps"; 1.43 mm. long; widest at level of "shoulder humps" which occur slightly anterior to middle; with numerous long slender spinules on dorsal and dorsolateral surfaces. Anal tubercle and six spinnerets as usual in the genus. The colulus appears to be reduced. Tracheal spiracle near base of spinnerets with a poorly developed chitinous lip.

Color in alcohol. Legs generally light yellowish with many grayish and brownish spots together with dark rings, more marked on first two pairs. Each chelicera has a small dark spot in front near base. Carapace: the eyes are ringed with reddish pigment; there is a median dorsal grayish stripe extending from the PE backward and diminishing to a termination between an irregular V-shaped dark mark which extends forward from the depression at the center of the posterior declivity. The sternum is a clear yellowish. Abdomen: the dorsum from opposite the posterior border of the "shoulder humps" to base is richly variegated with black, yellow, and red marks of a great variety of shapes; behind the "shoulder humps" the dorsum is whitish with narrow reddish transverse procurved lines connected laterally with black elongated spots; the venter is provided with several median dark spots and dark lateral bars.

Female allotype. Total length 2.925 mm. Carapace 1.49 mm. long; 1.17 mm. wide opposite third coxae where it is widest; narrowed to .65 mm. wide just behind PLE. Otherwise essentially as in male.

Eyes. AME separated from one another by 7/5 of their diameter, from ALE by about 2/5 of their diameter. PME separated from one another by about 5/9 of their diameter, from PLE by slightly more than their diameter. Laterals separated only by a line. Seen from above, posterior row slightly procurved; seen from in front, anterior row the same, measured by centers. Central ocular quadrangle wider in front than behind in ratio of about 4 : 3, wider in front than long in ratio of about 8 : 7. Ratio of eyes AME : ALE : PME : PLE = 10 : 8 : 8 : 8.5. Height of clypeus somewhat greater than diameter of AME. Otherwise essentially as in male.

Chelicerae. Basal segment .814 mm. long. The spinules along the promargin of the fang groove are more conspicuous than in the male. Otherwise essentially as in that sex.

Maxillae, Lip, and *Sternum.* Essentially as in male.

Legs. 1243. Width of first patella at "knee" .231 mm., tibial index of first leg 6. Width of fourth patella at "knee" .154 mm., tibial index of fourth leg 8.

(All measurements in millimeters)

	Femora	Patellae	Tibiae	Metatarsi	Tarsi	Totals
1.	2.860	.725	2.925	2.730	1.300	10.540
2.	2.405	.645	2.145	1.885	1.040	8.120
3.	1.495	.390	1.105	1.040	.715	4.745
4.	2.080	.455	1.495	1.300	.780	6.110

Spines. Small spines between the robust spines on the first and second legs are much more conspicuous and more regular in occurrence than in the male. First leg: femur dorsal 1-1-0-0-1-1, prolateral 0-1-1-1-0, retrolateral with a row of 16-18 short stiff stridulation spinules in proximal third and with one robust spine near distal end, ventral with a double row of long slender spinules; patella only dorsal 1(weak)-1; tibia dorsal 0-1-1-1-0, prolateral with 0-1-1-1-1-1-1-1-0 robust spines and short curved spines between the more robust spines usually four in each series increasing in length distally, retrolateral 0-0-1-0-1(weak), ventral 0; metatarsus dorsal a row of 12-15 long slender spinules, hardly spines, prolateral 1-1-1-1-1-0, retrolateral 0 but with numerous bristles, ventral only numerous bristles. Second leg: femur dorsal 0-1-0-0-1-1, prolateral only with a row of short stiff spinules to oppose the corresponding similar spinules on first femur, ventral essentially as in first, retrolateral apparently only a single spine near distal end; patella as in first; tibia dorsal 0-1-1-1-1, prolateral 0-1-1-1-1-0 and with a series of shorter weaker curved spinules following each of the larger robust spines. retrolateral only 0-1-0, ventral 0; metatarsus dorsal only a row of bristles or slender spinules, prolateral 1-1-1-0-0 with three series of shorter weaker curled spines following the robust spines as follows: 4, 5, and 12 or 13, retrolateral only a row of bristles or weak slender spines, ventral the same. Third leg: femur only dorsal 1-1-0-0 and numerous stiff bristles; patella as in first; tibia apparently only dorsal 0-1-0-0; metatarsus apparently only dorsal and prolateral 0-1-0-0. Fourth leg: femur dorsal 1-1-1-0-0, elsewhere 0 except for the frequent weak long slender spines, hardly more than bristles; patella essentially as in first; tibia dorsal 0-1-0-1-0, prolateral and retrolateral 0-1-0, ventral 0-1p-0-1p-0; metatarsus only prolateral 0-1-0-0 and retrolateral 0-1-0-0-0.

Abdomen. Except for sexual differences essentially as in male.

Epigynum. Similar to that of *M. verecundus* Chickering but with distinct differences; massively tubercular; with a small shallow depression at each anterior lateral corner (Fig. 6).

Color in alcohol. Similar to that of male except that the variegated abdominal area extends over a large part of the dorsum behind the "shoulder humps." Considerable variation in color has been noted among the paratypes.

Type locality. Male holotype and female allotype from the Canal Zone Experiment Garden, August, 1954. Two male paratypes from near Pedro Miguel, C. Z., August, 1954 and Canal Zone Experiment Garden, C. Z., August, 1954. Female paratypes from near Chiva, C. Z., July, 1954; Summit, C. Z., July, 1950; Arraijan, R. P., July, 1950.

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BREVIORA

Museum of Comparative Zoology

CAMBRIDGE, MASS. JUNE 29, 1956 NUMBER 58

SEQUENCE OF PASSERINE FAMILIES (AVES)

BY E. MAYR AND J. C. GREENWAY, JR.

At the XI International Ornithological Congress at Basel, Dr. Stresemann proposed that a committee be appointed which would recommend to the editors of ornithological journals a standardized sequence of the families of Passerine birds. Dr. Stresemann pointed out that some editors follow Hartert, others Sharpe's Handlist, others the sequence of the AOU, and still others the recently proposed sequence of Mayr and Amadon (1951). If a reader wants to find a given family in an article, he may have to look either at the beginning or in the middle or at the end depending on the particular sequence adopted by the respective editor.

As a result of Dr. Stresemann's suggestion a committee was appointed by the president of the Congress with the following members:

Dr. G. C. A. Junge, Chairman
Rijksmuseum Nat. Hist., Leiden
Prof. J. Berlioz
Museum d'Hist. Nat., Paris
Prof. Dr. G. Dementiev
Zool. Mus. University, Moscow
Prof. E. Mayr
Mus. Comp. Zool., Cambridge, (Mass.)
Mr. R. E. Moreau
Edward Grey Institute, Oxford
Dr. F. Salomonsen
Zool. Museum University, Copenhagen
Prof. Dr. E. Stresemann
Zool. Museum University, Berlin

In the discussion, it was pointed out that more and more editors adopt the sequence of already published volumes of Peters' Checklist, and the editors of Peters' Checklist were requested to submit to the committee the sequence which they had been planning to use. Dr. Mayr expressed the views of the editors by saying that they would very much like to follow a standardized and universally adopted sequence, in view of the fact that there are no decisive arguments available in favor of any of the previously proposed sequences. He stated that the editors of Peters' Checklist would be willing to adopt whatever sequence the committee would vote for.

REPORT OF THE EDITORS OF PETERS' CHECKLIST

In order to facilitate the work of the appointed committee, the editors of Peters' Checklist submitted to that body some tabulated historical material on sequences adopted by earlier authors. In the introduction to this report the following subject matter was discussed:

The task of the student of avian classification is particularly difficult because too little is as yet known about the paleontology of the songbirds to be of help in devising a sound classification. It is evident for this and more basic reasons that any linear order must be arbitrary. Three considerations usually guide those who attempt to find a suitable sequence:

(A) To follow as closely as possible the traditional arrangements, except where subsequent work has shown conclusively that a change is advisable;

(B) To place families near each other which are presumably closely related;

(C) To place the more primitive families near the beginning and the more advanced families near the end.

The following comments may be made on these three principles.

(A) *Traditional arrangements.* In nearly all recently proposed sequences it is acknowledged that the larks and the swallows are aberrant in various ways. These two families are, therefore, usually disposed of at the beginning of the system. The remaining bulk of songbirds is usually grouped into three major assemblages: (1) Old World Insect-eaters and relatives (Campephagidae, Pycnonotidae, Sylviidae, Timaliidae, Turdidae, Muscicapi-

dae, etc.), (2) New World Insect-eaters and finches, (3) crows, birds of paradise, and associated families. All the more peculiar and isolated families, as well as the Old World Nectar-eaters, are grouped rather irregularly within this broad framework. The sequence of the three major assemblages is by no means standardized, and to achieve a universal (or at least general) acceptance of one should be particularly the object of the committee.

The sequence 1, 2, 3 is that of Shufeldt (1904), Sharpe's Handlist, Hartert (in reverse here), the official Checklist of Australian Birds of 1926, Chasen's Handlist (1935), Mathews' Systema (1930), and more recently of the Checklist of Japanese Birds (1942), Berlioz (1950), Mayr and Amadon (1951) and Biswas (1952).

The sequence 1, 3, 2 was suggested first by Wallace (1874), as far as we can discover. This arrangement was based on the reduction in the number of primaries. As early as 1885 Sharpe remarked that it was difficult to follow it in a linear sequence. However, it was followed in certain sections of the Catalogue of Birds in the British Museum, but in others the arrangements of Sundevall (1872) and Garrod (1876) were adopted. We cannot find that the exact order of the "Catalogue of Birds" has been followed by anyone. This same order (1, 3, 2) was adopted by Stejneger in 1885. Evans (1899) used this order in the Cambridge Natural History, Sclater used it in 1930, and Stresemann again in the Handbuch der Zoologie (1934).

Finally, the sequence 3, 1, 2 was adopted by Wetmore and Miller (1926), and has been the order used in the American Ornithologists' Union Checklist (1931) and in works following the A.O.U. Checklist.

It should be added parenthetically that neither Fuerbringer (1888) nor Gadow (1893, 1898) made any attempt to classify the Oscine Passeres into families or subfamilies.

(B) *Mutual relationship.* To determine exact interrelationships of these families is in many cases very difficult, if not impossible. The system of songbirds abounds in artificial aggregates such as the "finches" or the "shrikes" of old, groups which may have little in common, except, for instance, the shape of the bill. In the improvement of the grouping considerable progress has been made in recent years such as the breaking up

of the artificial assemblage "finches" into carduelines, buntings (Emberizidae) and cardinals, or the assembling of the vireos, wood warblers, tanagers, and related families into a single aggregate. There are still many conventional groupings such as Paridae - Sittidae - Certhiidae which are presumably quite artificial. Yet, it would serve no useful purpose to break up these well-known sequences, until additional information sheds new light on the relationship of these families.

(C) *Phylogenetic sequence.* A satisfactory classification into "primitive" or "specialized" families is virtually impossible for the exceedingly similar groups of songbirds. The convenience of placing the rather undifferentiated "Old World Insect-eaters," and particularly the very generalized Campephagidae and Pycnonotidae near the beginning, is now accepted by the great majority of classifiers. But whether to follow the sequence 1, 2, 3, or 1, 3, 2 — that is, whether to consider the finches or the crow and bird-of-paradise group relatively more specialized — depends entirely on the criteria used. If adaptation to a seed diet or loss of the tenth primary are considered characters of great importance, then the sequence 1, 3, 2 is certainly best. However, if the cerebralization of the Corvidae and the extraordinary courtship habits of the birds of paradise and bower birds are considered indications of evolutionary significance among songbirds, then the sequence 1, 2, 3 is to be preferred.

The recent realization that the cone-billed birds ("finches") form an artificial, polyphyletic assemblage has weakened the support for sequence 1, 3, 2. Not only should the true finches (including Carduelinae) be removed from the New World Emberizidae-Cardinalinae assemblage (Tordoff 1954) but likewise the Estrildidae should be removed from the Ploceidae (Steiner 1955). Possibly the Estrildidae are related to the cardueline finches, both groups showing a curious mixture of primitive and advanced characters. The loss of the outermost primary which has happened in many families of birds independently and irregularly is, like all loss-characters, a very unsafe taxonomic criterion. All this militates against the sequence 1, 3, 2.

However, weighty arguments can also be advanced against the sequence 1, 2, 3. To consider cerebralization a most important character (Portmann) is somewhat anthropomorphic, as Wetmore (1951) has rightly observed. Furthermore, high cerebral-

ization has also occurred among Non-Passeres (Psittaci), and the relationship Corvidae-Paradisaeidae-Ptilonorhynchidae is by no means unequivocally established. In many purely morphological respects (bill, wing) the families of this group are undoubtedly more generalized than are some of the finches, and particularly the nectar-eating birds.

There is, thus, no decisive criterion that would permit coming to an unequivocal conclusion. It should be added that it would be shortsighted to accept a sequence which would satisfy European and American ornithologists only, but not those in the remainder of the world. The placement of the birds of paradise and bower birds may be immaterial to the student of European or of North American birds, but no world list of birds can be prepared which does not pay as much attention to the classification of these families as to that of the finches or thrushes.

It appears to the editors of Peters' Checklist that the 1, 2, 3 sequence is the one most widely used in the ornithological literature of the world. Since they know of no decisive reason for changing it, they have adopted a sequence which agrees roughly with the order 1, 2, 3.

ACTIONS OF THE COMMITTEE

The editors of Peters' Checklist requested that the members of the Committee express their preference between the sequences 1, 2, 3 and 1, 3, 2 and 3, 1, 2, and they used this opportunity to ask for suggestions concerning the placement of individual families.

The result was that the members of the Committee (Berlioz, Dementiev, Junge, Mayr, Moreau, Salomonsen, and Stresemann) voted unanimously in favor of the sequence 1, 2, 3. They also submitted questions concerning the family rank of certain genera and groups of genera and suggested a number of modifications. Before these are discussed, two matters of policy, which will guide the editors of Peters' Checklist, may be stated.

(A) There are a number of natural groups among the Oscines such as the thrush-flycatcher group, the "New World finches," and others delineated in Mayr and Amadon, 1951. In a linear listing unrelated groups of families must often of necessity be placed next to one another. This does not imply that such adjacent families are considered related, but is merely the un-

avoidable consequence of having to present a three-dimensional phylogenetic tree cut up into a one-dimensional linear sequence. As a result the Bombycillidae, for instance, are found next to the Cinclidae, the Pachycephalinae next to the Paridae, the Meliphagidae next to the Emberizinae, etc. Family group headings will be used in Peters' Checklist in order to minimize the effect of such misleading, but unavoidable groupings.

(B) The editors consider it unwise in such an essentially uniform group as the Oscines to recognize many families containing only a single species. They prefer to place somewhat isolated species in separate subfamilies, near the families with which the genera are traditionally associated. This they intend to do for such genera as *Hypositta, Dulus,* and *Pityriasis.* There are many additional genera of songbirds which could be treated with equal justification as separate families, such as *Lamprolia, Tichodroma, Promerops,* and others. Such a multiplication of families would not be constructive in the absence of sound anatomical support for the splitting.

The following comments concern the placing of individual families and deal with questions raised by committee members.

1. *Alaudidae.* Should this family, currently listed near the beginning of the Oscines, be transferred nearer to the Emberizidae, a position which it held in some of the older classifications?

Answer: This is not advisable. The Alaudidae are a very peculiar family. They differ from all other Acromyiodean Passeres by having not only the front but also the back of the tarsus scutellate and in having the pessulus rudimentary. This indicates that the larks may not be closely related to any of the other families. Since they are not specialized to any great extent they are probably best placed near the head of the list. Two functional characters, the heavy bill in some of the seed-eating genera, and the reduction in the number of primaries, cannot be considered evidence for relationship to the finches.

2. *Grallinidae and Artamidae.* Should these families be transferred from a place near the Laniidae to the neighborhood of the Callaeidae?

Answer: Yes. It is advisable for two reasons to keep together all peculiar Australian families, the relationship of which is obscure. It is probable that these families had their origin in the Australian region and that they are distantly related. It is also

desirable for purely practical reasons to have all purely Australian families near each other. In view of a superficial similarity, it was once believed that the Artamidae might be related to the Vangidae. However, there is no anatomical evidence available in favor of such an association and much zoogeographical and biological evidence which contradicts it.

3. *Bombycillidae.* Should this family be transferred from a position near the Sturnidae to one nearer to the Laniidae?

Answer: Yes. The Bombycillidae are presumably more closely related to some of the families in group 1 than to those in group 3.

4. *Ptilogonatidae and Dulidae.* Should not these two groups be retained as families?

Answer: They are better placed as subfamilies for the reasons stated above under B.

5. *Pityriasis.* Does the inclusion of this genus in the Prionopidae reflect true relationship?

Answer: Perhaps not, but with the available evidence it is not possible at present to make a satisfactory decision on relationship. There is no support for the belief that it might be related either to the Starlings or to the Shrikes (in the restricted sense). Since it is not advisable for the reasons stated above under B to separate the genus in a monospecific family, it will be best to list it as a subfamily in the Prionopidae where the genus has been listed traditionally.

6. *Estrildidae.* Should they be combined with the Ploceidae or be treated as a separate family?

Answer: Steiner (1955) has listed much evidence indicating that the Estrildidae deserve family ranking, indeed that they may not even be closely related to the Ploceidae.

7. *Turdidae, Sylviidae, Muscicapidae, Fringillidae, Ploceidae, Emberizidae.* Should not all these be retained as families?

Answer: For the reasons stated by Hartert, the first three should be combined in a single family. Fringillidae and Ploceidae should be retained as families while the Emberizinae should be retained as a subfamily of the New World finches. The oldest family group name proposed for the New World finches is apparently Emberizoidea (Suschkin 1925). The name of the family then would be Emberizidae.

The final sequence of the families of Oscine Passeres which emerged from these discussions was submitted to the committee, which agreed with it, except that Prof. Berlioz stated that he still preferred a placement of the Alaudidae near the Emberizidae. The editors of Peters' Checklist still feel that such an arrangement has less to recommend it, for the anatomical reasons stated above. The sequence approved by the committee is as follows:

Sequence of Oscine Families

Alaudidae
Hirundinidae
Motacillidae
Campephagidae
Pycnonotidae
Irenidae
Laniidae
Prionopidae
Vangidae
Bombycillidae
    Bombycillinae
    Ptilogonatinae
    Dulinae
Cinclidae
Troglodytidae
Mimidae
Prunellidae
Muscicapidae
    Turdinae (incl. Zeledonia)
    Timaliinae (incl. Chamaea)
    Paradoxornithinae
    Polioptilinae (incl. Rhamphocaenus and Microbates)
    Sylviinae (incl. Regulus, Leptopoecile, Lophobasileus)
    Malurinae
    Muscicapinae
    Monarchinae
    Pachycephalinae
Paridae
Sittidae
    Sittinae
    Hypositinae
    Neositinae
Certhiidae
Dicaeidae

Nectariniidae
Zosteropidae
Meliphagidae
Emberizidae
    Emberizinae
    Cardinalinae = Richmondeninae
    Tanagrinae = Thraupinae
    Tersininae
    Coerebinae
Parulidae
Drepaniidae
Vireonidae (incl. Vireolanius + Cyclarhis)
Icteridae
Fringillidae
    Fringillinae
    Carduelinae
Estrildidae
Ploceidae
Sturnidae
Oriolidae
Dicruridae
Callaeidae
Grallinidae
Artamidae
Cracticidae
Ptilinorhynchidae
Paradisaeidae
Corvidae

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A NEW SUBGENUS OF *CHAMAELEO* FROM RHODESIA AND NEW RACE OF *MABUYA* FROM KENYA COLONY

By ARTHUR LOVERIDGE

Fifty years ago when Boulenger (1906, Ann. Mag. Nat. Hist., (7), **18**, p. 346, fig.) described *Rhampholeon marshalli* from Mashonaland, he remarked on the only occurrence of this genus south of the Zambezi as being "of very great interest." In assigning *marshalli* to *Rhampholeon*, Boulenger was undoubtedly guided by his own key (1887, Cat. Lizards Brit. Mus., **3**, p. 438) to the genera of chameleons.

More recently Parker (1942, Bull. Mus. Comp. Zool., **91**, p. 82) examined *marshalli* for certain osteological characters, in which respect he found it agreed with other continental species of *Rhampholeon*, a group I have since suggested should be regarded as only a subgenus of *Brookesia*.

Dr. V. FitzSimons (1943, The Lizards of South Africa, p. 172, pl. xxi, fig. 5) also treated *marshalli* as the only South African representative of *Rhampholeon*. He personally collected topotypes in Chirinda Forest, Selinda Mountain, as well as an extensive series from Vumba Mountain, also in Southern Rhodesia. Thirty-one of these specimens of *marshalli* are now in the Museum of Comparative Zoology and were examined by me when making a synopsis of the continental African *Brookesia* (subgenus *Rhampholeon*). At that time (1951, Bull. Mus. Comp. Zool., **106**, p. 182, footnote) I rejected *marshalli* as a *Rhampholeon*, despite its bicuspid claws, referring it to *Chamaeleo* on account of its prehensile tail.

Actually the bicuspid claws (present or absent in *Rhampholeon*) constitute the only character in which *marshalli* differs from the forms assigned to *Chamaeleo;* thus it bridges the gap

between *Chamaeleo* and the subgenus *Rhampholeon* of *Brookesia*.[1] With a view to inviting attention to the intermediate status of this peculiar little chameleon, I suggest it should be made the type of a subgenus of *Chamaeleo*, viz.

Bicuspis subgenus new

Type. *Rhampholeon marshalli* Boulenger; known only from Southern Rhodesia.

Diagnosis. General appearance and soft nasal protuberance resembling that of *Chamaeleo* rather than *Rhampholeon*. Scales on soles smooth; claws bicuspid; tail prehensile, half to two-thirds the length of head and body. The tail is included in the length of head and body from 1.6 to 2.1 times, with an average of 1.86 times for our entire series of 31 *marshalli*. The largest of the series, a topotypic gravid ♀ (M.C.Z. 44445), measures 103 (68 + 35) mm.

The only *Brookesia* (subgenus *Rhampholeon*) with a tail anything like as long proportionately as that of *marshalli*, is *B. k. kersteni* (Peters), the claws of whose forefeet have a secondary cusp — though a secondary cusp is lacking on the claws of the forefeet of its northern representative *B. k. robecchii* (Boulenger).

Mabuya bayonii keniensis subsp. nov.

When the Museum of Comparative Zoology received a pair of typical *Mabuya bayonii* Bocage from Chitau, Bihe District, Angola, in 1936, it was immediately apparent that its East African representatives should be separated, if only on the basis of their strongly tricarinate dorsal scalation. The matter was deferred until such time as a revision of all African *Mabuya* could be undertaken, or a decision reached as to whether *bayonii* itself should be treated as a race of *gravenhorstii* Duméril and Bibron of Madagascar. As time for any such thorough investigation is lacking, I propose the name *Mabuya bayonii keniensis* subsp. nov.

Holotype. Museum of Comparative Zoology No. 29662, an adult ♂, from the northern Uaso (Guaso) Nyiro, Sotik, Kenya

[1] As Angel (1942, Mem. Acad. Malgache, **36**, pp. 154, 178) designated no type for his genus *Evoluticauda*, I suggest that *Brookesia nasus* Boulenger be so regarded.

Colony. Collected by the Smithsonian-African Expedition, 1909.

Paratypes. A specimen from Mount Kenya (U.S.N.M. 40710), another from Wambugu (U.S.N.M. 40781), a third from Lake Sergoit (Sirgoit: U.S.N.M. 42024), and three others (U.S.N.M. 40947-8 and M.C.Z. 29663) with the same data as the type.

Unquestionably the juvenile from a salt marsh on the Loita Plains, recorded by Angel (1922) is referable to this Kenya race, as are also four listings of *bayonii* by me (1923; 1924; 1929; 1937). Less certain as to which race it should be assigned is Oscar Neumann's specimen from "Sero" (? Ssera, Lake Tanganyika) referred to *Mabuia bayoni* (*sic*) by Tornier, 1896 (Die Kreichthiere Deutsch-Ost-Afrikas, Berlin, p. 42); this formed the basis of subsequent listings by Tornier (1897; 1900) and Nieden (1913), who added a series taken between Lake Victoria and Nguruman (i.e. Ngurumani).

For the loan of the paratype material in the United States National Museum, as well as an Angolan *b. bayonii* (U.S.N.M. 26389) for comparative purposes, I am indebted to Dr. Doris M. Cochran.

Diagnosis. Dorsals tricarinate, whereas in *b. bayonii* they are strongly quinquecarinate. Certain other characters may prove to have an average difference, but this cannot be demonstrated until more material of typical *bayonii* is available.

Description. Based on the holotype (variations of paratypes are placed in parentheses). Supranasals in contact behind the rostral; centre of nostril in advance of, even though slightly, the vertical of the suture between rostral and first labial; postnasal in contact with first labial only (except on right side of U.S.N.M. 40710, and both sides of U.S.N.M. 40781, where it touches the second labial also); anterior loreal in contact with first and second labials (or occasionally second only); supraoculars 3, the first and second being fused into a single shield (3-4 in paratypes); supraciliaries 4-5 (3-5), first largest; subocular narrowed inferiorly, reaching the lip between the fifth and sixth upper labials (in all); lower eyelid with a transparent disk that is subequal to, or slightly larger than the ear-opening, which has 2 (2-3) more or less acuminate lobules projecting from its anterior border; frontonasal in contact with the first (as it is fused with the second) supraocular (though usually *not* in con-

tact with the first); *frontoparietal single,* larger than the interparietal, which separates the parietals completely; nuchals multicarinate.

Midbody scale-rows 36 (34-36), *dorsals strongly tricarinate;* preanals not or but slightly enlarged; scales on soles not or but slightly pointed; subdigital lamellae smooth; toes of the adpressed hind limb meet the finger tips (or fail to meet, or extend to wrist) of the backward-pressed forelimb.

Color. Above (pale or dark) olive brown; dorsum with several longitudinal series of black (and white) flecks (or ocelli); a cream (or white) dorsolateral line extends backwards from the supraocular region to some distance along the tail; from the white labials a lateral line extends along the flanks on to base of tail. Below, white, uniform.

Size. Total length of type ♂ (M.C.Z. 29662), 148 (62 + 86) mm.; of paratype ♀ (M.C.Z. 29663), 160+ (82 + 78+) mm., tail-tip missing.

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Museum of Comparative Zoology

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A NEW SPECIES OF AGRIOGNATHA FROM JAMAICA, B. W. I.

BY ARTHUR M. CHICKERING

In connection with my study of the genus *Tetragnatha* Latreille, 1804 from Panama I have also had the opportunity to study several species believed to belong to the rather poorly-known genus *Agriognatha* O. P. Cambridge, 1896. Apparently there is at least one species in Panama not included among those recognized by F. P. Cambridge in 1903 and not described by any later author. It is expected that a description of this new species will be published shortly.

For some time prior to her death in 1953, Miss E. B. Bryant of the Museum of Comparative Zoology at Harvard College had been engaged in a study of a fairly representative collection of spiders from Jamaica, B. W. I. This collection had come from several sources but it had been assembled largely through the interest of Mr. C. Bernard Lewis, Curator of the Science Museum, Institute of Jamaica, Kingston, Jamaica. The collection is now in my possession and it is hoped that considerable time can be devoted to its study during the next few years.

Among the new Tetragnathinae selected by Miss Bryant for description was the species here described in accord with my usual procedure. I have thought it appropriate to name the species in honor of Miss Bryant who for many years gave unstintingly of her time and energy to the care of the large collection of spiders in the Museum of Comparative Zoology at Harvard College. So far as I know, this is the only species of *Agriognatha* reported from the island of Jamaica.

The holotype and allotype will be deposited in the collection of the Museum of Comparative Zoology at Harvard College.

Genus AGRIOGNATHA O. P. Cambridge, 1896

The genus *Agriognatha* O. P. Cambridge, 1896 was based upon a male from Costa Rica. In 1897 Simon described a species from St. Vincent as *Cyrtognatha serrata*, apparently following Keyserling who established the genus *Cyrtognatha* in 1881. F. P. Cambridge had Simon's *C. serrata* for study and regarded it as congeneric with *A. bella* (O. P. Cambridge) from Costa Rica. He considered it probable that *Cyrtognatha* Keyserling was the same as *Agriognatha* O. P. Cambridge. He also noted that the name *Cyrtognatha* was preoccupied and he placed all species regarded by the authors as belonging to either genus in the genus *Agriognatha* although he had doubts regarding the proper position of *A. lepida* (O. P. Cambridge). Petrunkevitch (1911) placed all five species then known in the genus *Cyrtognatha*. Roewer (1942) has retained this practice. I have not seen *Cyrtognatha globosa* Petrunkevitch, described from a female taken in the San Lorenzo River region of Panama but it seems unlikely that this species belongs in the genus *Agriognatha* as the latter is now understood. It now seems to the author of this paper that the two genera under consideration here are distinct but that all species recognized by Miss E. B. Bryant (1940, 1945) from Cuba and Hispaniola can safely be placed in the genus *Agriognatha*. This also seems certain for the species from Jamaica described in this paper.

AGRIOGNATHA BRYANTAE SP. NOV.

(Figures 1-5)

Male holotype. Total length 3.965 mm. (chelicerae not extended anterior to head region). Carapace 1.745 mm. long, 1.30 mm. wide opposite second coxae where it is widest; rather sharply narrowed opposite first coxae; median thoracic pit rather shallow and broad (considerably different from that seen in specimens from Panama).

Eyes. Eight in two rows as usual in the genus; LE extend slightly beyond border of head. Viewed from above, anterior

row strongly recurved, posterior row moderately recurved; viewed from in front, anterior row moderately recurved, posterior row slightly procurved, both measured by centers; central ocular quadrangle wider in front than behind in ratio of 9 : 8, as wide in front as long. Ratio of eyes AME : ALE : PME : PLE = 9 : 8.5 : 8.5 : 7. AME separated from one another by 11/9 of their diameter, from ALE by 5/3 of their diameter. PME separated from one another by nearly three fourths of their diameter, from PLE by about 7/4 of their diameter. Laterals separated from one another by a little less than the radius of PLE. Lateral eyes on a moderately prominent tubercle. Height of clypeus equal to diameter of AME.

Chelicerae. Very divergent, nearly horizontal; in place of the basal boss there is a prominent tubercle from which a ridge extends nearly to the base of the fang; basal segment of each chelicera 1. 235 mm. long and, therefore, nearly two thirds as long as carapace. Fang long, slender, somewhat sinuous, and with a prominent cusp on the inner surface just proximal to the middle. The fang groove has a robust non-bifurcate tooth near the base of the fang on the promargin together with three small teeth; the retromargin has four small teeth as shown in Figure 1.

Maxillae. Essentially parallel but with distal third slightly curved outward and considerably widened; slightly more than twice as long as lip.

Lip. Considerably wider at base than long; sternal suture gently procurved; sternal tubercles prominent at ends of sternal suture.

Sternum. Cordiform; moderately convex; slightly longer than wide between second coxae where it is widest; moderately extended between all coxae; terminates in a blunt point between bases of fourth coxae which are separated by slightly more than one third of their width.

Legs. 1243. Width of first patella at "knee" .220 mm., tibial index of first leg 5. Width of fourth patella at "knee" .165 mm., tibial index of fourth leg 7.

	Femora	Patellae	Tibiae	Metatarsi	Tarsi	Totals
	(All measurements in millimeters)					
1.	3.770	.810	3.770	4.192	1.365	13.907
2.	2.990	.745	2.600	2.900	1.105	10.340
3.	1.560	.390	.910	1.170	.640	4.670
4.	2.210	.455	1.820	2.210	.780	7.475
Palp	.726	.185	.198	——	.682	1.791

Many true spines as well as hairs on all legs. It is considered unnecessary to record all spines, hence, only those which seem to be more or less distinctive are emphasized here. First leg: there is a row of four short but fairly robust ventral spines near the base of the femur together with a row of seven very short but fairly robust retrolateral spines extending through the proximal two thirds of the segment and also a long robust retrolateral spine near the distal end of this segment; the patella has the characteristic retrolateral chitinous ridge; the metatarsus has a row of about 25 short ventral robust spines extending nearly throughout the length of the segment. The second leg is essentially like the first in respect to the characteristics noted with the specialized robust retrolateral spine near the distal end of the femur arising from a raised base. The expected prolateral trichobothria on both third and fourth femora are present but are much less conspicuous than in the Central American species thus far observed.

Palp. Complicated; somewhat difficult to describe because of numerous associated apophyses. The paracymbium appears to have a somewhat characteristic terminal enlargement. Near the tip of the cymbium there is a small pit, regarded as a type of sense organ. The same type of presumed sense organ has been noted on related genera and species. See Figures 2 and 3 for details of palpal structure.

Abdomen. Unnotched at anterior end which is bluntly rounded; 2.34 mm. long; 1.06 mm. wide near middle; with spiracle near base of spinnerets; with a well defined colulus, oval in outline; with genital fold (Fig. 5) only slightly posterior to openings of book lungs.

Color in alcohol. Chelicerae brown; legs yellowish brown with many irregular darker areas especially on dorsal surfaces. Carapace: with a narrow brown marginal stripe from opposite

PE to opposite third coxae where it becomes a wide stripe which continues to posterior border; also with an irregular broad median dark stripe from PME to median thoracic pit. Abdomen: a broad serrated median dark gray stripe extends from base to spinnerets; on each side of this there is an irregular light stripe with scattered silvery spangles; the lateral sides are dark gray with oblique extensions dorsally; the venter is yellowish with a row of small silvery spangles on each side.

Female allotype. Total length 4.94 mm.; including the chelicerae 5.46 mm. Carapace 1.95 mm. long, 1.43 mm. wide opposite interval between second and third coxae where it is widest; other features essentially as in male.

Eyes. Central ocular quadrangle about as wide in front as long. Ratio of eyes AME : ALE : PME : PLE = 9 : 10 : 9 : 8. AME separated from one another by 10/9 of their diameter, from ALE by slightly less than twice their diameter. PME separated from one another by 10/9 of their diameter, from PLE by twice their diameter. Laterals separated from one another by about ¼ of the diameter of ALE. Height of clypeus equal to slightly more than ⅔ of the diameter of AME. Other features essentially as in male.

Chelicerae. Robust; only slightly divergent and porrect; basal segment 1.04 mm. long; fang regularly curved and without special features; promargin of fang groove well marked, with three teeth; retromargin of fang groove with four teeth (Fig. 4); some variation in placement and relative sizes of the teeth has been noted and must be expected among paratypes.

Maxillae, Lip, and *Sternum.* Essentially as recorded for the male.

Legs. 1243. Width of first patella at "knee" .264 mm., tibial index of first leg 7. Width of fourth patella at "knee" .198 mm., tibial index of fourth leg 10.

	Femora	Patellae	Tibiae	Metatarsi	Tarsi	Totals
	(All measurements in millimeters)					
1.	3.380	.845	3.140	3.412	1.365	12.142
2.	2.600	.780	2.190	2.632	1.040	9.242
3.	1.495	.435	.845	.975	.715	4.465
4.	2.210	.487	1.495	1.820	.780	6.792

All legs with stout spines and hairs but the spines seem not to be specialized as in the male. The trichobothria on the third and fourth femora essentially as recorded for the male.

Abdomen. Very gibbous dorsally just behind the middle but this swelling seems to be completely lacking in some female paratypes; 3.575 mm. long; 2.080 mm. wide opposite the gibbosity where it is widest; genital groove as shown in Figure 5.

Color in alcohol. Chelicerae much lighter than in male with mottled gray markings in front in basal half. Otherwise essentially as in male.

Type locality. Male holotype and female allotype from Hardwar Gap, Jamaica, B. W. I., June 27, 1954. Several paratypes of both sexes from the following localities: Blue Mountains, August, 1934 (Darlington); St. Andrews, Clydesdale, July, 1950 (Bengry); Hardwar Gap, June, 1954[1]; Hanover, Askenish, trail to Dolphin's Head, June 24, 1954.

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[1]Since the completion of this paper two females and one adult male believed to belong to this species have been collected at Hardwar Gap, Jamaica, in July, 1955, by Dr. Allan F. Archer who has kindly loaned these specimens for examination.

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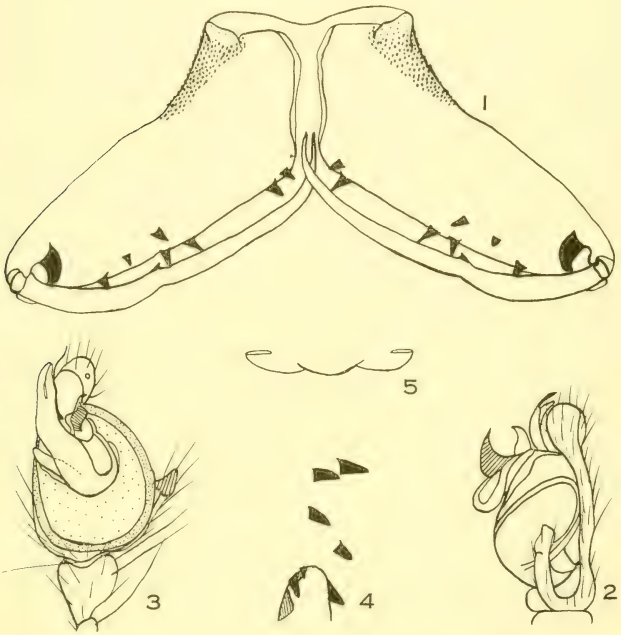

External Anatomy of *Agriognatha bryantae* sp. nov.

Fig. 1. Male chelicerae, from in front.
Figs. 2-3. Tarsus of male palp; lateral and ventral views.
Fig. 4. Female cheliceral teeth.
Fig. 5. Genital furrow of the female.

BREVIORA

Museum of Comparative Zoology

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ON REGENERATION BY EARTHWORMS OF A SPECIES OF THE LUMBRICID GENUS *DENDROBAENA* EISEN 1874.

By G. E. GATES

Regeneration, either cephalic or caudal, after natural or experimental amputation, for any species of *Dendrobaena* has not been recorded hitherto, though several of the head regenerates attributed by Morgan to *Eisenia foetida* (cf. Gates, 1953, 1954) probably were *D. octaedra*. Some data as to regeneration in another species of the genus can now be presented.

The worms, presumably all of an athecal morph frequently called *Bimastos tenuis* in the past, were clitellate and were secured early in the summer in Michigan. Amputation was without anesthesia. Amputees were kept in damp leaves at 22° C for the periods indicated in the tables.

The author's thanks are extended to Prof. Murchie for making this material available for study.

Anterior regeneration in *D. rubida* (Savigny, 1826)

All regenerates (cf. Table 1) are hypomeric. Metamerism in most regenerates deviates more or less from normal. Regeneration of a head clearly is possible at all levels back to and including 13/14. The regenerate at 17/18 lacks normal anal or buccal sculpturing distally and, since nephropores are unrecognizable, provides no external indications as to whether it is of cephalic or caudal organization.

Abnormal metamerism and hypomery at anterior levels, in certain other earthworm species studied by the author, resulted from unfavorable conditions either in the external or internal environments. Accordingly, metamerically normal regenerates at

all levels to 13/14 and equimery at least to 5/6 can be expected in *D. rubida* when conditions are more favorable.

The level at which the indeterminate monstrosity was developed is close to, if not actually in, a region where regenerative capacity in *E. foetida* (cf. Gates, 1949-1950) is bipotential. Monstrosities such as the one under consideration often are produced in morphogenetic regions of dual capacity. However, the data now available as to the results of posterior amputation in *D. rubida* scarcely warrant anticipation of heteromorphic tail regeneration in that species. Presumably then, a regenerate developing at 17/18 in optimal conditions will be normally cephalic.

Especially noteworthy, even in these few instances, is absence of any indication of decline in number of segments regenerated as level of amputation moves posteriorly (cf. Gates, 1949, p. 137).

TABLE I

Head regeneration in *Dendrobaena rubida*

Serial number	Level of regeneration	Segments in regenerate	Stage of regenerate	Days of regeneration	Remarks
1	2/3	1	2	19	
2	3/4	1	3	19	Metamerism still indistinct in regenerated left halves of iv-vi.
3	5/6	3	4	32	Regenerate metamerism nearly normal.
4	5/6	4	4	32	Regenerate metamerism nearly normal but 6/7 abnormal in regenerated right halves of vi-vii.
5	6/7	3	4	32	Metamerism nearly normal.
6	6/7	4	−3	19	Metamerism probably was developing abnormally.
7	7/8	2	4	37	Metamerism not quite normal. Regenerated ventral half of viii abnormal.
8	7/8	3	3	19	

Serial number	Level of regeneration	Segments in regenerate	Stage of regenerate	Days of regeneration	Remarks
9	7/8	3+	3	19	Proximal portion of regenerate too short for a normal segment.
10	8/9	4	3	19	Metamerism apparently developing abnormally in regenerated right halves of ix-x.
11	8/9	4	4	32	Regenerate segments ii-iv not quite normal.
12	8/9	4	4	32	Segment iv too large. Excised dorsal half of ix had been regenerated.
13	8/9	4	–3	19	Metamerism apparently normal.
14	11/12	5?	4	32	Regenerate metamerism abnormal.
15	13/14	5?	–3	32	Metamerism in regenerated left halves of xiv-xvi probably developing abnormally.
16	13/14	5-6?	–3	30	Metamerism rather indistinct in regenerated portions of xiv-xv, ventral half of xiv and a small portion of xv.
17	17/18	4-6?	–3	32	Regenerate terminating distally in rounded knob like a rudimentary prostomium but towards the ventral rather than the dorsal side.

Except as indicated otherwise above, excisions appear to have been transverse and along intersegmental furrows.

Stages. 1. Prostomium and buccal invagination as yet unrecognizable.
2. Prostomium and mouth developed.
3. Intersegmental furrows demarcate regenerate into segments.
–3. Furrows still indistinct.
4. Pigment present but obviously different from that of substrate.
5. Setae and nephropores recognizable.
6. Pigment now like that of substrate, external stigmata of regeneration, except for typical metameric anomalies, unrecognizable.

Posterior regeneration in *D. rubida*

An anus of more or less normal appearance had been acquired, at end of a July-August period of nineteen days, by the six worms from which a posterior portion of the intestinal region (cf. Table II) had been excised. Healing probably had been enteroparietal. The new anal region had not yet been delimited from the last substrate segment, by development of an intersegmental furrow, in Nos. 4-6 where little or no indication of reorganization is externally recognizable. A very small anal region, in No. 2, is demarcated by an intersegmental furrow and again there are no other external indications of reorganization.

A terminal portion of No. 1, presumably comprising only the last segment, at time of preservation was being reorganized. Completion of the process apparently under way probably would have resulted in development anteriorly of eight new setal follicles with setae and appearance of an intersegmental furrow demarcating a terminal anal portion from a metamere with the usual stigmata of regeneration. Reorganization, instead of regeneration, would then have been recognizable externally only if the original nephropores had been retained in the smaller daughter segment or if some of the pigment had escaped lysis.

Reorganization, accordingly, had been most drastic and had taken place most rapidly at the anteriormost level of amputation.

Evidence as to tail regeneration has been sought in several hundred individuals of *D. rubida* that have been available from various states and from other countries. Many of these worms certainly are posterior amputees and some of the others, obviously brevicaudate, very probably are. No tail regenerates were found. Externally recognizable indications of reorganization were noted but rarely, and in each case there could have been produced, in addition to the anal region, only one or two new segments.

Homomorphic tail regeneration, from a growth zone of rapid segment production (Gates, 1948) obviously does not, usually, follow posterior amputation in this species.

TABLE II

Results of posterior amputation in *D. rubida*

Serial number	Level of amputation	Number of excised segments	Remarks
1	42/43	?	Terminal substrate segment has lost much pigment, setae and nephropores.
2	54/55	?	An intersegmental furrow delimits small white anal region from last substrate segment.
3	65/66	12	Same as in No. 2.
4	80/81	6	Anal region not delimited from last substrate segment which still has setae and nephropores.
5	85/86	7	Anal region not delimited from last substrate segment where some of the setae still are present.
6	87/88	10	Anal region not delimited.

Time allowed for regeneration, 19 days.

Discussion

Homomorphic tail regeneration does not necessarily follow immediately after amputation and may not begin until nine months later. The process gets under way in some earthworm species, regardless of time of amputation, only when the "internal environment" permits. Differences in that environment may well be responsible for discordant results obtained by different investigators who have used the same species. As the importance of the unknown factors of the internal environment of earthworms seems not to have been appreciated, the following instance is worthy of record.

Individuals of *Eisenia foetida*, in the author's earlier studies (Gates, 1949-1950), after removal of the posterior portion at

levels behind 40/41, almost always regenerated promptly and in all seasons of the year. Several dozen specimens of that species, apparently in good condition, from three localities, were deprived of their tails in the region between 40/41 and 50/51 on three occasions in the last five years, to provide material for a school demonstration. All of the worms survived the operation. Not one showed any indication of formation of new segments during a period of several weeks though the external environment was, so far as could be determined, the same as before.

Summary

Cephalic regeneration in an anterior direction can be expected, in *D. rubida* in optimal conditions, at all levels back to 17/18, with equimery back to 5/6. Caudal regeneration in a posterior direction, from a growth zone of rapid segment formation, cannot be expected ordinarily if at all. Instead, the terminal substrate segment may be reorganized into an anal region and one or two metameres with some of the stigmata of regeneration, the reorganization possibly being more drastic and more rapid when at more anterior levels.

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BREVIORA

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A THIRD LEAF-NOSED SPECIES OF THE LIZARD GENUS *ANOLIS* FROM SOUTH AMERICA

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and

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It gives us considerable pleasure to be able to announce the discovery of another specimen of the leaf-nosed anoles. It is the first time that leaf-noses have been known to occur outside of the Amazon Basin. The locality from whence it came is on the Pacific side of the Andes in the hot and humid "Choco" portion of northwestern Ecuador. While the new individual is obviously closely related to the holotype of the species described by Myers and Carvalho (1945), the differences are sufficiently great that we feel justified in calling it a new species.

Since the original specimen was collected, the Escuela Polyteenica has sent several other collectors into the area and the senior author made several trips to the type locality during the summer of 1954 when he obtained comparative material of other species of the genus *Anolis*,[1] but no one has yet been able to obtain additional representatives. Nothing is known as yet as to the habits of these unusual animals or the use to which the rostral appendage is put.

[1] Field work in Ecuador during 1954 by the senior author was supported by a grant from the Penrose Fund of the American Philosophical Society.

Anolis proboscis, new species

Type. Museum of Comparative Zoology No. 54300, a mature male from the neighborhood of Cunuco, a small town at 1200 meters elevation, five kilometers northwest of Mindo, on the south bank of the Río Mindo, a northern tributary of the upper Río Blanco, in Pichincha Province, Ecuador, collected by Antonio Proaño, during April 27-29, 1953.

Diagnosis. This new species is distinguished from all other species but one in the genus *Anolis* by the presence of an elongated, fleshy appendage, which is about as long as the head, on the snout. The only other species with a similar appendage is *Anolis phyllorhinus* Myers and Carvalho, from which it differs in having a serrated edge on the rostral appendage, 10-11 upper labials to a point below the center of the eye, 9-10 lower labials, and a median dorsal row of scales which is produced into a serrated dorsal crest, as well as other characters mentioned below.

Description. Snout with an elongate, fleshy appendage projecting anteriorly, with a distinct downward curve; length of appendage approximately equal to length of head, measured from tip of rostral to ear opening. Appendage arises approximately half way between eye and nostril, on midline; strongly serrate along upper margin to level of rostral, serration less marked but still serrate to tip, both above and below; nine scales wide at level of rostral, tapering to three at tip; rather fleshy and rounded at snout, tapering to thin and vertically compressed at tip. Scales on dorsum of head smooth, pavimentose, irregular. No distinct depression in frontal region, frontal ridges almost obsolete, faintly indicated from middle of supraorbital semicircles to frontal area, where they end at level of anterior margin of eye. Canthus rostralis not strongly angulate but rather rounded, with 5-6 canthal scales from nostril to eye; area between canthi occupied by irregular, smooth scales, 8-9 in a straight line between canthi at level of origin of nasal appendage and approximately the same number between the posterior ends of the canthi, due to gradual increase in size of scales in frontal area. Scales of supraorbital semicircles large, somewhat scarified, slightly angulate; not in contact on midline, separated by two rows of smaller, pavimentose scales. Supraorbital scales in contact with semicircles, no granular scales separating them;

three or four scales in center of supraorbital area are markedly larger than others, but no rows or series are formed. Interparietal large, considerably larger than ear opening; separated from supraorbital semicircles by two rows of scales.

Rostral completely horizontal below appendage, extending well beyond lip line. Nostril sunk in a single scale. Two scales between canthus rostralis and upper labials anteriorly, four or five posteriorly, no distinguishable horizontal rows of loreal scales. Last scale in canthus rostralis followed by a single superciliary, which is in turn followed by the granular area of eyelid. Granules of eyelid continuous with smaller scales of supraocular region; these two areas are not separated by a series of superciliaries. Single row of three or four enlarged subocular scales from loreals to granular postocular region and between the granules of eye and the upper labials; terminal scale of this row enters the labial row on both sides, and on one side extends to the lip line. Temporal region with many small, pavimentose scales, not arranged in rows or series. Ear opening quite small. Eleven upper labials on left side, ten on right to below center of eye, one additional labial behind eleventh on left, one right subocular enters labial row, followed by granular scales. First labial on both sides wedged between rostral and second labial, lower edge only partially on lip line.

Mental almost completely divided on midline, suture incomplete anteriorly only. Nine lower labials on left, ten on right. Seven sublabials on each side, anteriormost in contact with lower labials, posterior four or five separated from labials by smaller scales; sublabials reduced in size posteriorly, gradually merge with other chin scales, which are small, numerous, and pavimentose or occasionally granular.

Body very slightly compressed, vertebral angle comparatively sharp. Dorsal crest of raised denticulations runs down spine from head onto tail, with 85 spines from back of head to level of posterior insertion of hind limbs. In several instances adjacent denticulations are fused, with sutures still visible. Scales on dorsum of body pavimentose, quite small, smooth, no enlarged paravertebral rows. Lateral scales approximately equal in size and appearance to dorsals. Granular scales, i.e., scales with raised centers rather than a flat surface, are present on neck, shoulders,

and above hind legs. Ventral scales considerably larger than dorsals and laterals, smooth, for most part in imbricate rows. Scales on throat quite granular except on moderately developed gular fold, where the scales are larger and quite imbricate. Imbricate scales of belly pass into pavimentose or even granular scales at level of pelvis, and remain so to anus. No enlarged preanal scales; no femoral or preanal pores.

Scales on all parts of limbs and feet subequal, pavimentose or slightly granular. Scales on dorsum of digits expanded, much wider than long, extend across dorsal surface of digit; smaller scales on lateral edges of digits, which are dorso-laterally flattened; expanded scales on ventrum of digits pavimentose at base of toe, lamellar on proximal part of toe. Lamellar counts are shown in Table 1.

Tail very strongly compressed, vertebral angle sharp, with a prominent dorsal crest. Scales at base of tail smooth, pavimentose, and irregularly arranged; gradually become larger, squarish, and arranged into vertical series, but still pavimentose at level of posterior end of hemipenial sheath. Two large, smooth scales form base of postanal hemipenial pockets. At this point the scale rows begin to become more prominent and imbricate, forming whorls; lowermost rows of scales begin to have keels at about ⅓ of length of tail, keels invade lateral rows until at ½ length of tail all rows are keeled; keels increase in prominence until at end of tail there are four pronounced edges formed by keels on four rows of scales.

TABLE 1

	Fore Foot	Hind Foot
Left	5-11-16-17-10	4-11-19-29-18
Right	5-11-17-17-10	4-12-14-30-18

Scale formulae for digits in holotype. All enlarged scales on the venter of each digit were counted, beginning with the first distinctly enlarged, pavimentose scale at the base of the toe and continuing to the tip of the expanded lamellar portion. Scales on the most distal, curved phalanx, which arises dorsally from the lamellar portion of the toe, are not included.

Dorsal ground color (in alcohol) a dull gun-metal blue, with

irregular, parallel, horizontal black streaks along vertebral margin. These streaks vaguely line up and form a pair of lateral bands between the limbs. Dark brownish-black spot at shoulder. Limbs and lateral surfaces spotted with light yellowish-white; limbs vaguely barred with darker blue; skin in interstices between scales of dorsum of digits light, giving appearance of banding on fingers and toes. Dorsum of head unicolor, as back; temporal region and lips lighter, with faint reddish or purplish tinge and a marked light spot over the ear opening. Ventral surfaces generally lighter, with vague reddish tints on chest and chin; belly stippled with light spots. Venter of limbs heavily spotted with white proximally, becoming totally white on foot. Tail alternately barred with gun-metal blue and blackish, bands approximately equal in width.

Measurements (in millimeters). Total length (not including rostral appendage), 171; body length (rostral to vent), 74; tail length, 97; head length (rostral to ear opening), 23; head width at widest point, 11; length of rostral appendage, 23; length of fore limb, 31; length of hind limb, 42.

Remarks. Since only a single male of *A. proboscis* is known, the possibility exists that the specimen belongs to a previously described Ecuadorian form, known either solely from females or from juvenile males, both of which might lack the rostral appendage. Since the species occurs in a very distinctive biotic region, the Choco of Ecuador, Colombia, and Panamá, it is also possible that it might be the first Ecuadorian representative of a Choco species. There are seventeen species which have been described from type localities within the biotic area. Of the sixteen that are currently considered valid species, eight (*chloris* Blgr., *eulaemus* Blgr., *festae* Peracca, *gracilipes* Blgr., *granuliceps* Blgr., *latifrons* Berthold, *maculiventris* Blgr., and *peraccae* Blgr.) have been previously recorded from Ecuadorian localities. While in the Choco area of Ecuador in 1954, the senior author collected four specimens of *A. breviceps* Blgr., three individuals of *A. peraccae* Blgr., and one of *A. festae* Peracca, at Hacienda Equinox, which is 30 kilometers northwest of Santo Domingo de los Colorados. *A. breviceps* had not been known from Ecuador. Seven additional species have been recorded in the literature as taken from Ecuadorian localities within the Choco area, although

their type localities are elsewhere. Two other taxons, *aequatorialis* Werner and *irregularis* Werner, must also be considered, since they were described from Ecuador with no added information, and no additional specimens have been taken to establish a range for the species.

There are sixteen species, including *albi* Barbour, *bitectus* Cope, *breviceps* Blgr., *fasciatus* Blgr. (with its synonyms *elegans* Blgr. and *irregularis* Werner), *festae* Peracca, *fraseri* Günther (with its synonym *devillei* Blgr.), *gracilipes* Blgr., *granuliceps* Blgr., *latifrons* Berthold (with its synonym *princeps* Blgr.), *lemniscatus* Blgr., *lemurinus* Cope, *macrolepis* Blgr., *maculiventris* Blgr., *notopholis* Blgr., *palmeri* Blgr., and *peraccae* Blgr., for which both males and females are known, and for which available specimens or descriptions provide many and obvious differences from *A. proboscis*. Females only are known of the species *antonii* Blgr. and *ventrimaculatus* Blgr., but the descriptions given for the types shows that these species are quite different from *A. proboscis*. Only males of *aequatorialis* Werner, *chloris* Blgr., *eulaemus* Blgr., *rosenbergi* Blgr., and *tropidogaster* Cope have been described in the literature, but here again each appears to be quite distinct. The sex was not given in the original descriptions of *binotatus* Peters, *gemmosus* O'Shaughnessy, and *lionotus* Cope, but they are sufficiently well described to eliminate them as available names for *A. proboscis*.

Myers and Carvalho (1945, p. 7) felt that the relationships of their new species were with the *punctatus* group of the genus *Anolis*, and this is undoubtedly true also of *proboscis*. They discussed *A. punctatus*, *A. boulengeri*, *A. transfasciatus* and *A. nasofrontalis* as probable members of the species group. They had no specimens of *A. boulengeri* available, and the specimens called *A. punctatus* were only tentatively identified as such. They had, however, excellent material of *A. transfasciatus* Amaral, a species they considered sufficiently similar to *A. punctatus* to suggest that the former might well be placed eventually as a subspecies or synonym of the latter.

A single specimen of *A. boulengeri* O'Shaughnessy, collected in Santiago-Zamora Province, Ecuador, in the region between the Río Pastaza and the Río Santiago, is catalogued as No. 45776, in the Museum of Comparative Zoology. It provides an

opportunity to compare data for this species with the notes made on other species by Myers and Carvalho. The specimen has, on its snout, a substantial protuberance which does not extend to any distance beyond the end of the jaw. This swelling is without doubt the primitive condition that led eventually to the elongation observed in *phyllorhinus* and *proboscis*. It is slightly more prominent than that of *A. transfasciatus* and presumably also of *punctatus*. In addition to the presence of keels on the ventrals, *A. boulengeri* differs from both leaf-nosed species and *transfasciatus* in the presence of keels on the enlarged supraocular scales. The suboculars and the lowest row of loreals form a straight series in both *boulengeri* and *phyllorhinus*, while in *transfasciatus* and *proboscis* the subocular series turns upward around the eye, not forming a linear series with the loreal row. There is no middorsal scale row in *boulengeri*. Two rows of scales, slightly larger than the other dorsals, occupy the vertebral line. There is no midventral row of scales. All dorsal, lateral, and ventral scales have keels which can be seen if examined under sufficiently high magnification. This is not true of *proboscis* or *phyllorhinus*, and apparently not true of *transfasciatus*. It appears, then, that *A. boulengeri* is quite distinct from all these species, and presumably, from *A. punctatus* as well. Verification of the latter assumption must await direct comparison of the two species.

Cope (1876, p. 165) described *Scytomycterus laevis*, from the Huallaga River, in eastern Peru, which had the rostral plate produced into a flexible appendage. Both *Anolis phyllorhinus* and *Anolis proboscis* are quite distinct from this species, for they have the snout projection composed of several rows of small scales, while *A. laevis* has an appendage composed of a single scale, the rostral. Boulenger (1885, p. 11) synonymized *Scytomycterus* Cope with the genus *Anolis*, where it has remained since.

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Anolis proboscis Holotype ♂ (M. C. Z. 54300).

BREVIORA

Museum of Comparative Zoology

CAMBRIDGE, MASS. OCTOBER 11, 1956 NUMBER 63

NEW BATHYAL ISOPODA FROM THE CARIBBEAN WITH OBSERVATIONS ON THEIR NUTRITION

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INTRODUCTION AND ACKNOWLEDGMENTS

In this paper 5 new species including 1 new genus of marine Isopoda are described. All were collected by the R/V VEMA, Cruise 8, 1955-56 with a single trawl using the closing-opening Epibenthic Trawl (Menzies, in press) from bathyal depths (680 fms.) in the Caribbean Sea at 16° 59.1′ N. Latitude and 79° 07.9′ W. Longitude (South of Jamaica). The substratum consisted of pteropod and foraminiferal ooze.

In addition to isopods, the trawl contained polychaete worms, a few ophiuroids and several amphipods.

The specimens have been deposited in the Museum of Comparative Zoology (abbreviated MCZ) whose publication of this manuscript is appreciated.

The research was supported by a Rockefeller Foundation Grant RF 54087 for research in deep sea biology.

ECOLOGY AND NUTRITION

The "stomach" contents of *Acanthocope spinosissima* Menzies (this paper, p. 2) which packed the gastric mill to swelling consisted foremost of bacteria-size and shape particles and some globular bodies, possibly protozoans. Next in abundance were

[1] Lamont Geological Observatory, Contribution No. 219, Biology Program No. 7.

the parapodial setae of some species of polychaete annelid, some demospongiae spicules, a few empty small foraminiferal tests, some diatom tests and a few tintinnoid loricae. These observations suggest that *Acanthocope spinosissima* is both carnivorous and a detrital feeder with possibly some selectivity in its nutrition.

SYSTEMATIC DESCRIPTION

Acanthocope spinosissima n. sp.

Figure 1

Synonyms. None.

Diagnosis. Front concave. Dorsum with three pairs of spines on somites 5-7 inclusive. First antenna with 10 articles, first swollen and spinulate at margins, second to fourth subequal in length, fifth longest, about 3 times the length of fourth. Pleotelson long spinulate apical spine. Uropoda uniramous, peduncle and ramus subequal in length, maxilliped with 7 coupling hooks. Coxal plates and lateral margins of body spinulate. Mandibular palp with one or two articles, last article much elongated.

Measurements. Holotype, length 8 mm., width 2 mm.

Type. Deposited in the MCZ, Cat. No. 12665.

Distribution. Known only from type locality.

Composition and affinities. Of the known species, *A. spinosissima* resembles *A. spinicauda* Beddard (1886) most. It differs from that species most obviously in having its pleotelsonal spines curved cephalad rather than caudad.

The type of this genus is *A. spinicauda* Beddard and although Beddard shows the uropoda as having five articles this is surely an error as is the apparent lack of fusion of the hinder peraeonal somites. The genus is close to *Eurycope* Sars (1864) and *Storthyngura* Vanhöffen (1914). It differs from both in having uni- and not biramous uropoda and in having a markedly pointed (spinelike apex) pleotelson and not a rounded or bifurcating one. The following species appear to belong to the genus:

Acanthocope spinicauda Beddard
Acanthocope acutispina Beddard
Acanthocope atlantica (Beddard)
Acanthocope intermedia (Beddard)

All are from bathyal or abyssal depths of the sea.

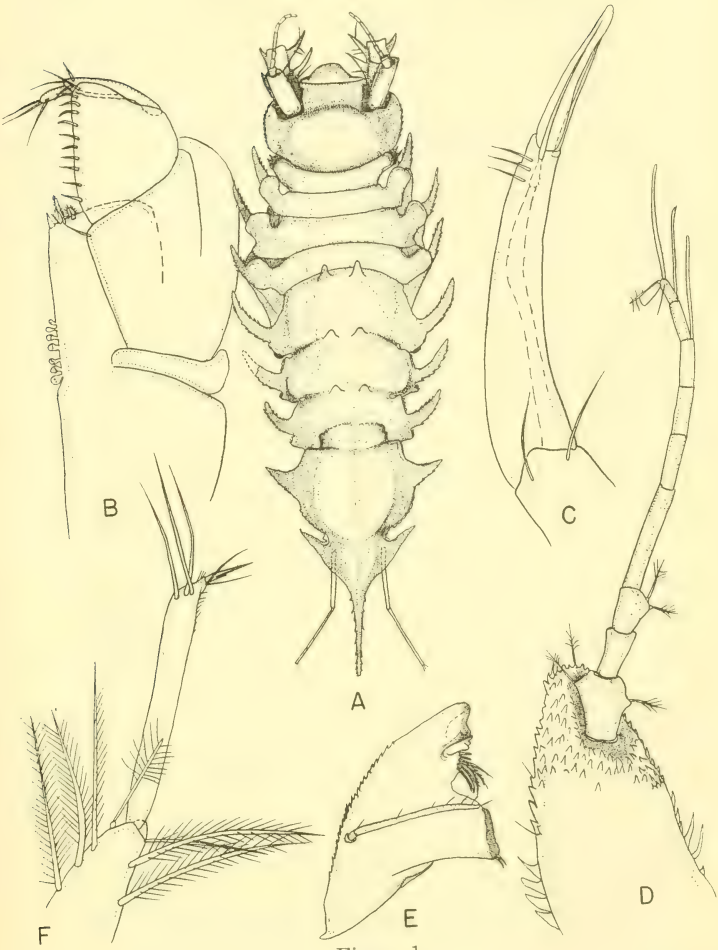

Figure 1

Figure 1. *Acanthocope spinosissima* n. sp., holotype female length 8 mm., *A*, toto; *B*, maxilliped; *C*, first peraeopod; *D*, first antenna; *E*, left mandible; *F*, seventh peraeopod.

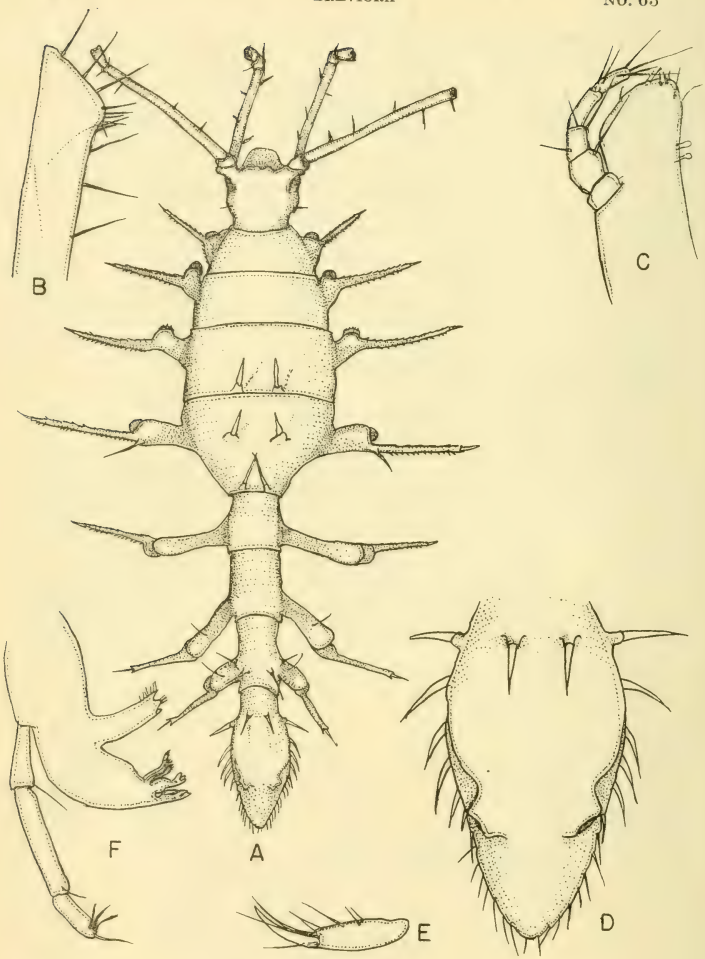

Figure 2

Figure 2. *Dendrotion hanseni*, n. sp., holotype male, length 3.5 mm. *A*, toto; *B*, first pleopod; *C*, maxilliped; *D*, pleotelson; *E*, gnathopod; *F*, left mandible.

Dendrotion hanseni, n. sp.

Figure 2

Synonyms. None.

Diagnosis. Lateral processes spinulate. Third peraeonal somite with one pair of dorsal spines; fourth somite with two pairs of dorsal spines; seventh somite and pleotelson with one pair of dorsal spines, pleotelson with 10-11 spinelike setae on lateral margins followed by a fringe of smaller setae around apex. Maxilliped with two coupling hooks. Apex of male first pleopod with four setae.

Measurements. Holotype male, length 3.5 mm., width 0.8 mm.

Type. Deposited in the MCZ, Cat. No. 12666.

Distribution. Known only from type locality.

Composition and affinities. The genus contains only two species, the type, *D. spinosum* G.O. Sars (1897), which was collected from the Hardanger Fjord at Mosterhaven, Norway, at 150 fathoms and the new one herein described. Previously the genus had been known only from Norway.

Genus Neoanthura, n. g.

Synonyms. None.

Diagnosis. Anthuridae with piercing and sucking mouth parts. Eyes lacking. First antenna with seven articles; second antenna with six articles comprising flagellum. Maxilliped composed of a single lanceolate article. All six pleonal somites clearly marked dorsally, statocyst lacking. Pleon not indurated. First two pairs of peraeopoda subchelate, others less so but with carpo-propod over-ridden by merus.

Type species. Neoanthura coeca, new species.

Composition and affinities. This genus contains only the type species. It is most closely related to *Paranthura* Bate and Westwood (1866) from which it differs principally in having a uni- and not a triarticulate maxilliped.

Neoanthura coeca, n. sp.

Figure 3

Synonyms. None.

Diagnosis. Mandibular palp triarticulate, lack setae. Apex of

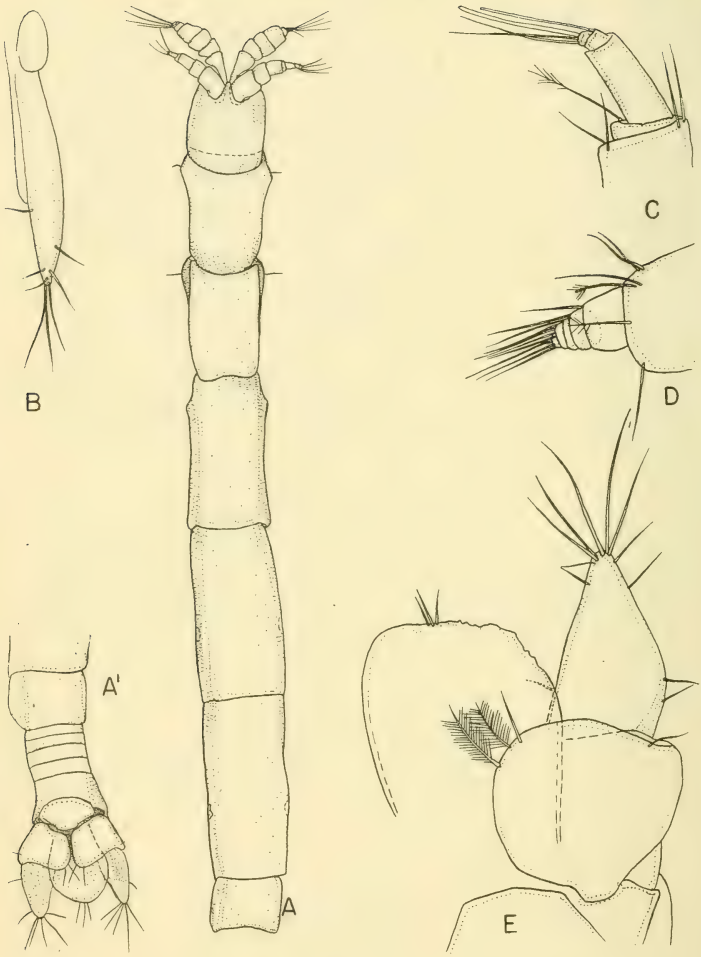

Figure 3

Figure 3. *Neoanthura coeca*, n.g., n. sp., holotype female. *A-A'*, toto; *B*, maxilliped; *C*, first antenna; *D*, second antenna; *E*, uropod and telson.

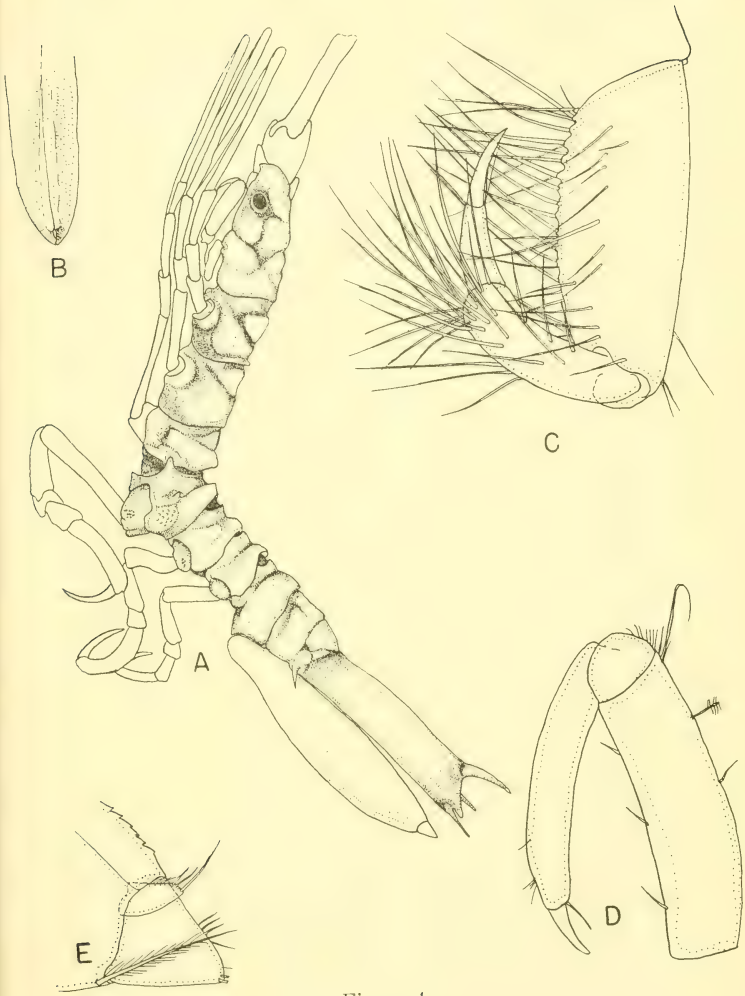

Figure 4

Figure 4. *Antarcturus annaoides*, n. sp., holotype male. *A*, lateral view; *B*, penis; *C*, gnathopod; *D*, seventh peraeopod; *E*, inner view of apex of uropod.

pleotelson rounded with only three setae. Margins of uropodal rami smooth with few setae. Frontal margin of cephalon pointed. Maxilliped with seven setae. Body smooth, glistening, a pair of setae present at lateral margins of first two peraeonal somites.

Measurements. Holotype female, length 3.75 mm.; width 0.25 mm.

Type. Deposited in the MCZ, Cat. No. 12667.

Distribution. Known only from type locality.

Composition and affinities. Unique.

ANTARCTURUS ANNAOIDES n.sp.

Figure 4

Synonyms. None.

Diagnosis. An *Antarcturus* with dorsum of body and pleotelson without spines. Eyes present. Coxal plates without lateral spines. Pleotelson with a pair of spines at anterolateral border and a similar pair at posterolateral angles as well as a horn-like spine on dorsum at midline of posterior border. Dactyls present on peracopoda one and seven. Second antenna exceeds two times the length of the body. Ventral surface of body without spines.

Measurements. Male holotype, length 13 mm., width 2.0 mm.; second antenna 25 mm. long.

Type. Deposited in MCZ, Cat. No. 12668.

Distribution. Known only from type locality.

Composition and affinities. The species closest relative appears to be *Antarcturus anna* (Beddard 1886), described in the "Challenger" report from 600 fathoms off the Rio de la Plata. It differs from that species in lacking a marginally serrated pleotelson and in lacking armed coxal plates.

IANIRELLA CARIBBICA, n. sp.

Figure 5

Synonyms. None.

Diagnosis. Front with median setiferous horn. Pleotelson with three spines at lateral border, and four on dorsal surface. First peraeonal somite with three dorsal spines. Second peraeonal somite with 7 spines on dorsum, third with 9; fourth with 9; fifth to seventh with 2. Maxilliped with two coupling hooks. First antenna with 13 articles.

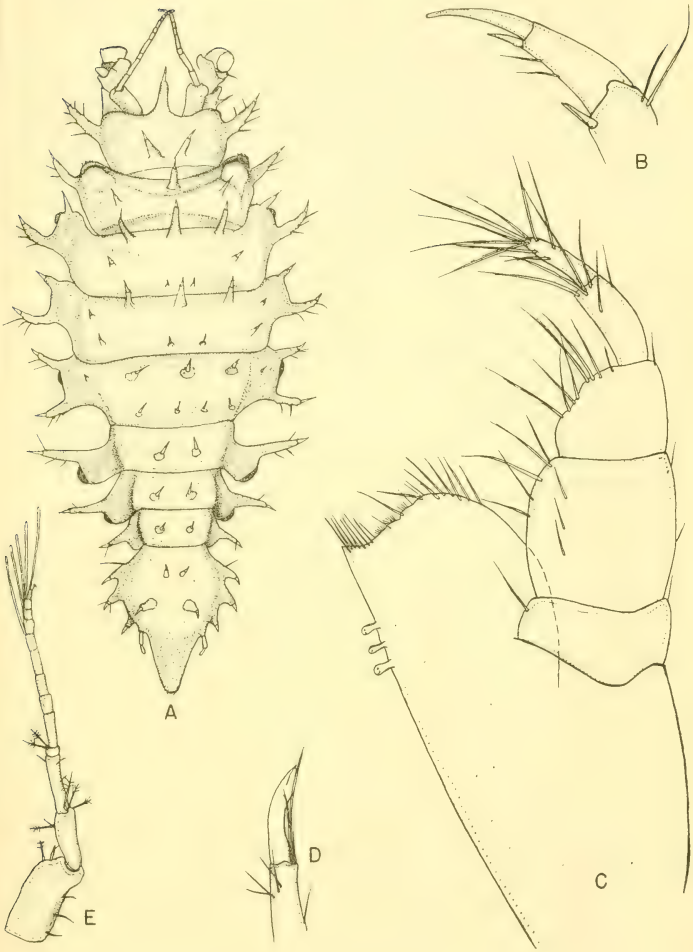

Figure 5

Figure 5. *Ianirella caribbica*, n. sp. *A*, type toto; *B*, dactyl first peraeopod; *C*, maxilliped; *D*, dactyl seventh peraeopod; *E*, first antenna.

Measurements. Holotype female, length 5.5 mm.; width 2.4 mm.

Type. Deposited in the MCZ, Cat. No. 12669.

Distribution. Known only from type locality.

Affinities. This species, being dorsally spined, is most closely related to *Ianirella nanseni* Bonnier (1896), a species collected by the "Caudan" from 950 meters depth north of the Azores at 40°38′ E. Longitude and 44°17′ N. Latitude. It differs markedly from that species in having 3, not 4 spines at each pleotelsonal border and 3 rather than 1 spine on the dorsum of the first peraeonal somite.

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BREVIORA

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RARE SPECIES OF COPEPODA, CALANOIDEA, TAKEN FROM THE IZU REGION

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INTRODUCTION

The present paper is part of a report on the pelagic copepods of the Izu Region, the Pacific Coast of Middle Japan. About three hundred and twenty species have been described from that region and a list of the species has been published in "Records of Oceanographic Works in Japan," vol. 1, no. 1, 1953. However, owing to various difficulties, the descriptions and figures have not as yet been published.

The author wishes to express his thanks for help received from Dr. A. Fleminger, U. S. Fish and Wildlife Service, a fellow worker with whom he has had occasion to discuss various copepod problems during the past year, and Dr. Elisabeth Deichmann, Curator of Marine Invertebrates, in the M.C.Z., Cambridge, Mass. It is due to their efforts that he has now the pleasure of seeing this contribution in print.

RYOCALANUS gen. nov.

Diagnosis. Body elongate; head separate from first thoracic segment; fourth and fifth segments separate. Rostrum stout, one-pointed. Abdomen five-jointed in male. First antenna 24-jointed; eighth and ninth joints fused; male with right antenna transformed into grasping-organ; joints 23 and 24 fused, hinge between joints 22 and 23. Second antenna as in *Drepanopsis* Wolfenden, with three setae on inner margin of second joint of exopodite; first basal joint with a brush of hairs in posterior aspect. Mandible with slender palp; endopodite two jointed.

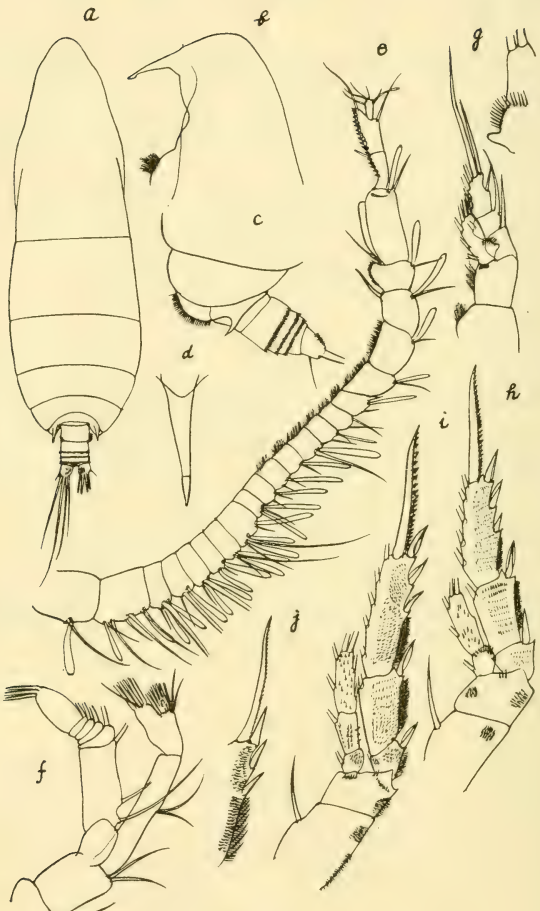

Figure 1. *Ryocalanus infelix* n. sp. *a*, Complete animal, dorsal view; *b*, head, lateral view; *c*, last thoracic segment and abdomen, lateral view; *d*, rostrum; *e*, grasping antenna; *f*, second antenna; *g*, first leg and proximal outer margin of endopodite; *h*, second leg; *i*, third leg; *j*, third joint of exopodite of fourth leg.

shorter than exopodite. First maxilla as in *Mimocalanus* Farran, but exopodite, second basal joint and lobes slender. Second maxilla as in *Pseudocalanus* Boeck; fifth lobe largest. Maxilliped as *Drepanopsis* Wolfenden except that distal two joints are furnished with well developed setae on outer margin. Swimming legs as in *Spinocalanus* Giesbrecht and *Monacilla* Sars except that distal joint of exopodite of first leg with a spine on outer margin at about mid-length of joint. Fifth pair of legs of male as in *Pseudocalanus*. Type species, *Ryocalanus infelix* n. sp.

Ryocalanus infelix sp. nov.

Description. Male: Length, 2.18 mm.; cephalothorax, 1.93 mm.; abdomen, 0.25 mm.; head separate from first thoracic segment; last two thoracic segments separate; cephalothorax elongate, ovate; head contracted anteriorly; last thoracic segment produced into an acute spine on each side, ventrally directed; ventral margin of segment furnished with fine spinules; rostrum one point and acute, in lateral view with a notch on posterior surface near distal end.

Abdomen five-jointed; segments and furca with proportional length of 32, 18, 11, 7, 14, 18 = 100; first abdominal segment about half as long as wide, with fine spinules on distal corner of right side; second to fourth segments with spinules on distal margin; furcal ramus wider than long, with five setae, outermost seta short and slender; dorsal surface of ramus with minute spinules; appendicular seta short.

Left first antenna damaged, with distal joints missing; joints eight and nine incompletely fused on anterior margin; joints with following proportional lengths:

Joint	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15
	20	14	5	5	5	5	4	7	5	6	6	6	6	6

Right antenna a grasping organ, extending to distal margin of second thoracic segment; joints eight and nine completely fused; joints 18 to 22 inflated; joint 20 with a strong seta on posterior margin; joint 21 with fine denticles and a seta on posterior margin; joint 22 highly chitinized on posterior margin and with a short distal seta; joint 23 and 24 incompletely separated, forming a comb-like projection with 19 denticles on posterior margin; posterior margin with a minute seta at junc-

Figure 2. *Ryocalanus infelix* n. sp. *k*, mandible; *l*, first maxilla; *m*, second maxilla; *n*, maxilliped; *o*, fifth pair of legs.

tion with joint 24; joint 25 with five setae and an aesthetask; joints 12-19 with hairs on posterior margin.

Second antenna with exopodite about as long as endopodite; exopodite seven-jointed, second joint with three marginal setae; distal joint of endopodite with eight plus six setae. Mandible with exopodite slightly longer than endopodite; exopodite five-jointed; endopodite two-jointed; distal joint of endopodite with ten setae; second basal joint with three setae; cutting edge with eight teeth. First maxilla well developed; outer lobe with four long and two short setae; exopodite with eleven setae; endopodite with seven plus six plus four setae; second basal joint with five setae; third inner lobe with four; second inner lobe with five setae; first inner lobe with 14 spines. Second maxilla normal; first lobe with four setae, second to fifth lobe, each with three setae; sixth lobe with two setae, distal one short, endopodite with six setae; first basal joint with an outer marginal seta. Maxilliped slender; outer marginal seta on fourth and fifth joint of endopodite long; second joint of endopodite the largest.

First leg with three-jointed exopodite and one-jointed endopodite; outer edge spine on joints of exopodite long, third joint with four inner marginal setae and two outer marginal spines, distal half of outer margin hollowed; endopodite with three marginal setae, two apical setae and a process on proximal outer margin; second basal joint with row of spinules on inner distal margin at base of endopodite; exopodite of right leg with an abnormal structure, inner marginal setae on second and third joints of exopodite converted into strong spines. Second leg with three-jointed exopodite and two-jointed endopodite; joints of exopodite — especially second and third — densely covered with fine spinules on posterior surface; third joint with five inner marginal setae; posterior surface of joints of endopodite with groups of spinules; terminal spine of exopodite with 23 teeth connected with what appears to be a thin lamella; outer margin of second joint, and proximal section of third joint of exopodite with acicular spines and a row of slender, curved spines (as in Figure 1 *h*); this arrangement of spinules observed also in exopodite of third and fourth legs; basal joint with groups of minute spinules; third leg with three-jointed exopodite and endopodite; joints of exopodite and endopodite with spinules on posterior surface as

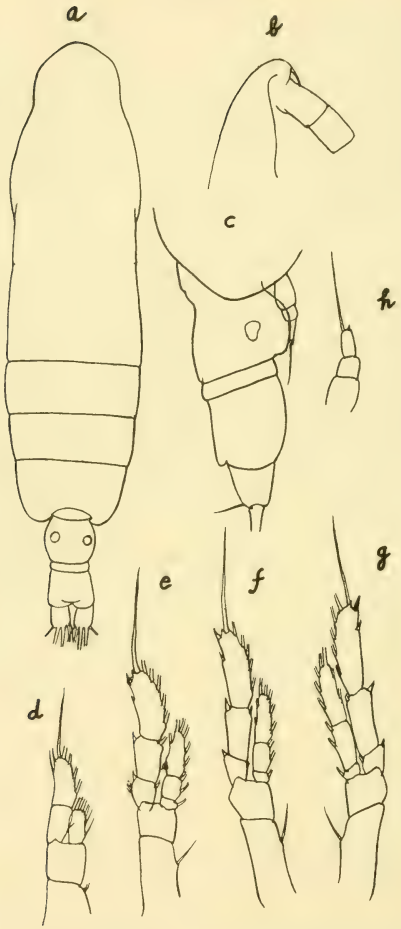

Figure 3. *Calocalanus gracilis* n. sp. *a*, Complete animal, dorsal view; *b*, head, lateral view; *c*, last thoracic segment and abdomen, lateral view; *d*, first leg; *e*, second leg; *f*, third leg; *g*, fourth leg; *h*, fifth leg.

in second leg; terminal spine of exopodite with 25 teeth; third joint of endopodite with six setae in all. Fourth leg with three-jointed exopodite and endopodite, and of similar structure as third leg; terminal spine of exopodite finely serrate.

Fifth pair of legs with five joints on each side; left leg much longer than right; terminal joints of each leg with two unequal apical spines; right leg with an outer edge spine on third joint.

Material. One adult male from a vertical haul, 1410 m.-0 m., near Izu, Suruga Bay, Japan (November 1938).

Material deposited. Kyushu University.

Remarks. The species appears to be allied to the genus *Autanepsis,* described by Wolfenden (1911, Report Deutsche Südpolar Expedition), in the structure of the swimming legs, but the mouth parts are entirely different. The grasping antenna of the present species differs from those found in the members of the tribe Heterarthrandria which have a movable articulation between the joints 18 and 19. The structure of the first to fourth legs resembles those of the Pseudocalanidae, yet the peculiar structure of the grasping antennae has not — as far as I am aware — been reported in the species hitherto described. At the present moment I therefore place this curious species in a new genus, under the name *Ryocalanus infelix,* in memory of my only son who lost his life in his early boyhood.

Calocalanus gracilis n. sp.

Description. Female: Length, 0.62 mm. Body slender, cephalothorax 3.5 times as long as wide; abdomen contained 4.8 times in length of cephalothorax. Abdomen with three segments, segments and rami with proportional lengths of 40, 8, 32, 20 = 100; genital segment as long as wide; furcal rami as long as wide.

Terminal joints of first antennae missing; length of the remaining joints as follows:

Joint	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15
	3.2	4.1	2.3	1.8	2.3	2.3	2.3	3.2	1.8	1.8	2.0	2.3	2.7	2.7

Swimming legs small; first leg with two-jointed exopodite and one-jointed endopodite; first basal joint with small spines on inner distal margin near the middle. Second to fourth leg each with three-jointed exopodite and three-jointed endopodite. First joint of exopodite of second leg with four small spines on outer

margin at base of outer edge spine. Third and fourth legs with joints of endopodite devoid of groups of spines on posterior surface; leaf-like spines of second and third joints of exopodite also absent. Fifth pair of legs three-jointed; terminal joint about as long as first joint, with an end-spine of similar length as the three joints taken together, and with a minute spine on outer distal corner.

Material. One adult female from a vertical haul, 50-0 m., near Izu, Suruga Bay, Japan (August 1937).

Material deposited. Kyushu University.

Remarks. Resembles *C. tenuis* Farran in dorsal view, but the small size and the structure of the swimming legs separate it from the latter which was originally described from the Bay of Biscay.

BREVIORA

Museum of Comparative Zoology

CAMBRIDGE, MASS. NOVEMBER 20, 1956 NUMBER 65

A NEW SPECIES OF AGRIOGNATHA (ARANEAE, ARGIOPIDAE) FROM PANAMA

By ARTHUR M. CHICKERING

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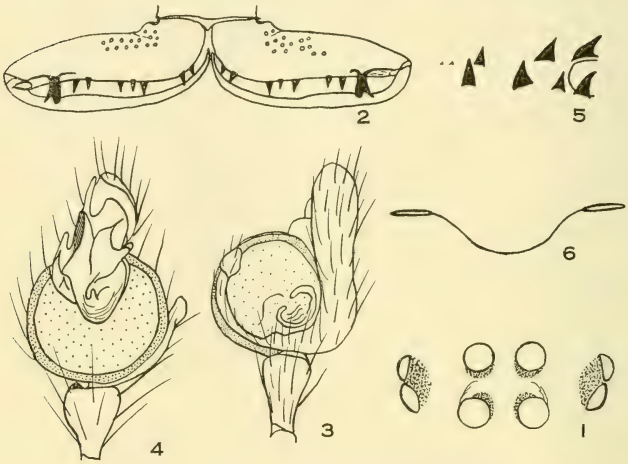
F. P. Cambridge (1903) recognized two species of *Agriognatha* from western Panama and another from Costa Rica although he was in some doubt as to the proper position of the Panamanian *A. lepida* (O. P. Cambridge). To my knowledge, no species of *Agriognatha* from Panama have been recognized since that time. No mention of the genus is made by Kraus (1955) in his recent paper on the spiders of El Salvador.

During my recent studies on the genus *Tetragnatha* Latreille, 1804 in Panama numerous specimens of what I am compelled to regard as a new species of *Agriognatha* O. P. Cambridge, 1896 have been sorted out of my collections. This species is described in accord with my usual procedure, and the types will be deposited in the Museum of Comparative Zoology at Harvard College. A single male of another species from El Volcan, R. P. has also appeared in my material. Unfortunately, this specimen has lost both palpal tarsi and, hence, is regarded as unworthy of a description at the present time. This latter species appears to be close to *A. bella* O. P. Cambridge from Costa Rica.

Genus AGRIOGNATHA O. P. Cambridge, 1896

In a recent paper (1956) describing a new species of *Agriognatha* from Jamaica, B. W. I., I have given reasons for retaining this generic name rather than returning to *Cyrtognatha* as Roewer (1942) has done. In view of the uncertainty regarding the relationship between the genus *Cyrtognatha* Keyserling, 1881

and the genus *Agriognatha* O. P. Cambridge, 1896 I think it is still desirable to retain the name given here.



External Anatomy of *Agriognatha insolita* sp. nov.

Fig. 1. Eye group of male from in front.

Fig. 2. Chelicerae and cheliceral teeth from in front.

Figs. 3-4. Male palpal tibia and tarsus; lateral and ventral views, respectively.

Fig. 5. Female cheliceral teeth.

Fig. 6. Genital groove of female.

Agriognatha insolita sp. nov.
(Figures 1-6)

Male holotype. Total length 5.59 mm. including chelicerae; exclusive of the chelicerae 5.2 mm. Carapace 1.95 mm. long; 1.17 mm. wide opposite interval between second and third coxae where it is widest; considerably narrowed opposite first coxae; median longitudinal thoracic groove well marked.

Eyes. Eight in two rows; viewed from above, both rows recurved with anterior row strongly so; viewed from in front, an-

terior row gently recurved, posterior row gently procurved, both measured by centers. Central ocular quadrangle slightly wider in front than behind, slightly longer than wide in front. Ratio of eyes AME: ALE: PME: PLE = 11: 10: 10: 9. AME separated from one another by about three-fourths of their diameter, from ALE by slightly less than 1.2 times their diameter. PME separated from one another by about four-fifths of their diameter, from PLE by 1.8 times their diameter. Laterals separated from one another only by a broad line (Fig. 1).

Chelicerae. Very divergent; nearly horizontal. Basal segment 1.625 mm. long and, therefore, about four-fifths as long as the carapace. The fang is moderately sinuous and without special features. Near the base of the fang on the promargin of the fang groove there is a robust bifurcate tooth and three other small teeth more proximal in position; the retromargin has four somewhat larger teeth (Fig. 2).

Maxillae. Nearly parallel; somewhat broadened distally; about three times as long as broad in middle; moderately concave along lateral borders; slightly more than twice as long as lip.

Lip. About as long as wide at base; sternal suture irregularly procurved; with pronounced sternal tubercles at ends of sternal suture.

Sternum. Essentially cordiform; as wide as long; moderately convex; moderately scalloped opposite each coxa; moderately extended between all coxae with second and third coxae relatively widely separated; continued by a narrow sclerite between fourth coxae which are only slightly separated.

Legs. 1243. Width of first patella at "knee" .264 mm., tibial index of first leg 5. Width of fourth patella at "knee" .214 mm., tibial index of fourth leg 8.

	Femora	Patellae	Tibiae	Metatarsi	Tarsi	Totals
1.	4.420	.910	4.615	5.200	1.365	16.510
2.	3.380	.750	2.762	3.250	.975	11.117
3.	1.625	.410	.975	1.235	.700	4.945
4.	2.730	.520	2.080	2.470	.885	8.685
Palp	.520	.220	.242	——	.770	1.752

(All measurements in millimeters)

With many true spines on all legs. Those which seem to be most distinctive occur as follows. First leg: near the base of the femur on the ventral surface there are three short robust spines in a short row; on the retrolateral surface there is a row of nine or ten spines several of which seem to be modified for some special use with the most distal one long and robust; the metatarsus has a series of about twenty-five short robust ventral spines beginning at the base of the segment and extending through about three-fourths of its length and diminishing in size distally. Second leg: essentially as in first with the special metatarsal spines less marked. The third femur has a row of five conspicuous trichobothria on its prolateral surface in the proximal fourth; the fourth femur has a row of eight similar trichobothria on its prolateral surface in the proximal third.

Palp. Complicated and somewhat difficult to describe because of the presence of numerous transparent tarsal apophyses. It appears to be rather typical of those described by Miss Bryant from Cuba and Hispaniola (1940, 1945). The paracymbium is long and slender with a terminal enlargement (Figs. 3-4).

Abdomen. Unnotched at base dorsally; only slightly extended over the carapace; 3.51 mm. long; .91 mm. wide; nearly uniform in width to the rounded posterior end.

Color in alcohol. Chelicerae reddish brown; elsewhere essentially like that of female except that there are fewer of the silvery spangles on the abdomen.

Female allotype. Total length including chelicerae 8.125 mm.; exclusive of the chelicerae 7.80 mm. Carapace 2.47 mm. long; 1.625 mm. wide opposite interval between second and third coxae where it is widest; with the cephalic region only slightly raised; the shallow thoracic median pit is shaped quite differently from that usually present in the genus *Tetragnatha* and is extended forward in a narrow point.

Eyes. Eight in two rows as usual; with laterals on a rather prominent tubercle; viewed from above, posterior row slightly recurved, anterior row strongly so; viewed from in front, posterior row gently procurved, anterior row moderately recurved; both measured by centers. Central ocular quadrangle only

slightly wider behind than in front; longer than wide behind in ratio of 11: 10. Ratio of eyes AME: ALE: PME: PLE = 10: 9: 10: 8. AME separated from one another by 1.1 of their diameter, from ALE by 2.3 times their diameter. PME separated from one another by 1.2 times their diameter, from PLE by 2.2 times their diameter. ALE separated from PLE by one-fourth of the diameter of PLE (some workers might regard them as being contiguous because the corneas are nearly so, but the margins of the corneal hypodermis are separated as indicated). Height of clypeus equal to .9 of the diameter of AME.

Chelicerae. Moderately well developed; only slightly divergent; basal segment 1.365 mm. long; fang regularly curved, without cusps; fang groove well marked; promargin of fang groove with only three teeth of moderate size plus two minute denticles; retromargin with four teeth also of moderate size but slanted irregularly (Fig. 5).

Maxillae. Slightly divergent, with outer distal corners considerably extended; longer than lip in ratio of about 9: 4; longer than wide in ratio of about 18: 7.

Lip. Only slightly broader at base than long. Sternal suture gently procurved; with pronounced sternal tubercles at lateral ends of suture.

Sternum. Essentially as in male.

Legs. 1243. Width of first patella at "knee" .330 mm., tibial index of first leg 5. Width of fourth patella at "knee" .242 mm., tibial index of fourth leg 8.

	Femora	Patellae	Tibiae	Metatarsi	Tarsi	Totals
1.	4.875	1.105	5.200	5.720	1.592	18.492
2.	3.510	.910	3.250	3.880	1.175	12.725
3.	2.000	.520	.975	1.560	.775	5.830
4.	3.185	.585	2.405	2.730	1.105	10.010

(All measurements in millimeters)

All legs with spines and hairs. The third femur has a row of six prominent trichobothria on its anterior surface in the proximal third of the segment; the fourth femur has a similar row of about fifteen prominent trichobothria.

Abdomen. Only slightly gibbous in anterior half; 5.525 mm. long; only slightly extended posterior to spinnerets; squarely truncate at anterior end; genital groove as shown in Figure 6.

Color in alcohol. Legs: generally yellowish with tibiae and metatarsi darker; irregular black streaks beneath patellae and distal ends of femora; grayish areas are frequent on several segments. Mouth parts are generally light yellowish brown with the fang darkest of all. Sternum light yellowish brown. Carapace light yellowish brown with darker markings. Abdomen: cardiac region very light yellowish; remainder of dorsal and dorsolateral areas light yellowish with many small silvery spangles; mid-ventral area light yellowish with a narrow row of silvery spangles on each side; farther laterally the venter is free of the silvery spangles.

Type locality. Both male holotype and female allotype are from Barro Colorado Island, C. Z., August, 1950. Male and female paratypes are in the collection from: Barro Colorado Island, C. Z., July, 1936; February, 1936 (Gertsch); August, 1939; May, 1946 (T. C. Schneirla); June-August, 1950; July-August, 1954; Arraijan, R. P., August, 1936.

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BREVIORA

Museum of Comparative Zoology

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THE CANINAE OF THE THOMAS FARM MIOCENE

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INTRODUCTION

The generic relationships of the various members of the Caninae from the Florida Miocene have been uncertain ever since Dr. E. H. Sellards first described a new species of *Mesocyon* from the Griscom Plantation in northwest Florida (Sellards, 1916). Our knowledge of the dogs of this epoch in Florida has been greatly increased by the work of Dr. Theodore E. White at the Thomas Farm between 1940 and 1946 (White, 1941, 1942, 1947) and by others who have worked at the site since then. The Thomas Farm locality has been described in those papers dealing with the earlier vertebrate finds (Simpson, 1932; White, 1942).

In carrying out this study all specimens studied by Simpson and by White have been examined, together with a cast of the type of *M. iamonensis* Sellards. In addition, much unstudied Thomas Farm material in the Museum of Comparative Zoology (M.C.Z.), University of Florida, and the Florida Geological Survey (F.G.S.), collected subsequent to the work of Simpson and White, has been available.

The types, or casts of the types, of the following species have been at hand for comparison or have been examined: *Mesocyon hortulirosae* Schlaikjer, M.C.Z. 2882; *M. geringensis* Barbour and Schultz, Univ. Neb. 1902; *M. drummondanus* Douglass, Carnegie Museum 792; *Tomarctus brevirostris* Cope, Amer. Mus. Nat. Hist. 8302, A.M.N.H. 13836 (type of *T. hippophagus* Matthew); *T. optatus* Matthew, A.M.N.H. 18916; *Cynodesmus thomsoni*[1]

[1] White (1941, p. 95) refers this species to *Tomarctus*.

Matthew, A.M.N.H. 12874, and *C. thoöides* Princeton Univ. 10412.

As a result of the study presented here, it is evident that the Thomas Farm Caninae are referable to two species representing two genera. These are *Cynodesmus iamonensis* (Sellards) and *Tomarctus canavus* (Simpson). *Tomarctus canavus,* the smaller of the two, and its synonyms, will be discussed first. Complete redescriptions are unnecessary, as they have been given in the original discussions.

Tomarctus canavus (Simpson)

Figures 1, 4

Cynodesmus canavus Simpson, 1932, p. 19, fig. 4; White, 1941, p. 91.
Tomarctus canavus (Simpson), White, 1942, p. 8, pls. 2, 6.
Tomarctus thomasi White, 1941, p. 94, pl. 14, fig. 3; 1942, p. 8.
Nothocyon insularis White, 1942, p. 7, pl. 1, fig. 3; 1947, p. 502, fig. 2, D, E.

In Simpson's type description of *Cynodesmus canavus* (F.G.S. V-5260) no mention is made of a comparison between this specimen and *Tomarctus,* although the type of *Cynodesmus nobilis* (F.G.S., V-5255) was compared with this related genus. The talonid of M_1 of the type of *canavus,* though considerably worn, retains enough of the characteristics to definitely identify it as *Tomarctus* (cf. Figure 4). In *canavus* the talonid of M_1 exhibits a ridge between the hypoconid and the entoconid that is characteristic of *Tomarctus.* This species also has two subsidiary cusps anterior to the hypoconid and entoconid respectively, the latter being the more pronounced. These cusps and the cross ridge are not present in *Cynodesmus* or *Mesocyon.* P^4 in the series exhibits a parastyle varying from incipient to small but definite. The lower premolars are less crowded than those of *T. thomsoni.* On comparing *Tomarctus canavus* with the specimens of *Tomarctus brevirostris* Matthew (1924) from the Snake Creek, it was found that the proportions and cusp arrangement were nearly the same, but the specimens of *T. brevirostris* were somewhat larger. White (1942) correctly interpreted *canavus* as having the generic characters of *Tomarctus* rather than of *Cynodesmus,* and referred it to that genus.

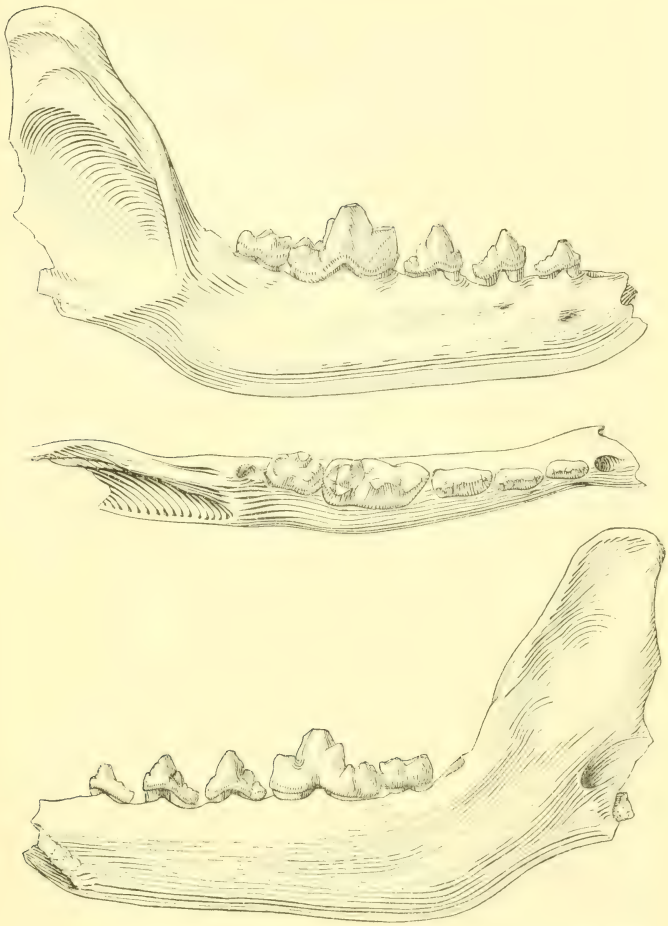

Figure 1. *Tomarctus canavus*, labial, occlusal and lingual views. MCZ 3628. X 1.

Tomarctus thomasi White was based on a partial left maxilla bearing P^4-M^2. White originally compared this species only with *T. optatus* and *T. brevirostris*. Later (1942; p. 8), he stated that *thomasi* was slightly larger than *canavus* with relatively larger, more crowded teeth. The differences between M.C.Z. 3628 and 3712 (the specimens that White evidently compared), slight in any case, disappear when the whole series is examined. The species *T. thomasi* cannot be maintained.

Nothocyon insularis was also based on a fragmentary maxilla. White placed the species in *Nothocyon* because of the spacing of the first and second molars, the quadrangular M^2, and the conical hypocone of M^1, relying largely upon the obtuse posterolateral angle of M^2 to exclude the species from *Tomarctus*. The spacing of M^{1-2} does not appear to differ markedly from that observed in other members of the series. The hypocone of M^1

MEASUREMENTS IN MILLIMETERS OF DEPTH OF RAMUS UNDER CENTER OF $\frac{M_1}{}$, LABIAL

MCZ + 3628	MCZ ++ 3629	MCZ ++ C 3712	MCZ FP 3924	MCZ * C 4242	MCZ * C 4333	MCZ ++ C 4334	MCZ + 4507	MCZ * 5814	MCZ ++ 7148
20.4	19.7	21.9	22.1	18.0	20.0	22.8	19.4	19.0	21.6

* ESSENTIALLY UNWORN
\+ SLIGHTLY WORN
++ MODERATELY WORN
FP WELL WORN
C- CRUSHED, MEASUREMENT NOT ENTIRELY RELIABLE

is slightly more conical but this is not a profound difference; M.C.Z. 3641, when unworn, may have been entirely comparable in this respect. M^2 is more quadrangular than in the other two available examples of the tooth. The difference is due to the structure of the external cingulum. This may be regarded as an individual peculiarity. In the description of a referred lower jaw (White 1947, p. 502), he observed that there was little difference between the alveolar length of this specimen and of those referred to *T. canavus*, but that it was more slender throughout, the teeth smaller and shorter crowned, the condyle shorter and smaller, and set at an oblique angle to the horizontal ramus, indicating a broad skull for this form. Experience with Thomas Farm material has shown that exact jaw angles, lengths, depth of rami, etc., are not too reliable, due to the distortion and

cracking that this material has undergone during the process of fossilization. The measurements as given on the opposite page demonstrate the variability in depth of ramus.

As may be seen from the analysis of the dental measurements (Table 1), the teeth referred to *insularis* by White are not significantly smaller than those referred by him to *canavus* and *thomasi*. As he noted, "the heel of the carnassial shows the ridge between the hypoconid and entoconid that is characteristic of *Tomarctus*." There is, in fact, no reason for separating *N. insularis* from *T. canavus*.

Cynodesmus iamonensis (Sellards)

Figures 2, 3

Mesocyon? iamonensis Sellards, 1916, p. 88, pl. 11, fig. 11; pl. 13, fig. 1; Simpson, 1930, p. 160.

Cynodesmus? iamonensis (Sellards) Simpson, 1932, pp. 14-19.

Cynodesmus nobilis Simpson, 1932, p. 17, figs. 1-3; White, 1941, p. 91.

Paradaphoenus nobilis (Simpson) White, 1942, p. 5, pl. 2, fig. 1; pl. 3.

Paradaphoenus tropicalis White, 1942, p. 5, pl. 1, fig. 2; pl. 4.

Paractis bathygenus White, 1947, p. 500, fig. 2A (in part, not including type).

This species has been buffeted about somewhat as regards its generic assignment. Sellards, who knew it only from the type, a maxillary fragment with P^4-M^2,[1] was quite justified, on that basis, in his tentative assignment to *Mesocyon*, this genus being similar to *Cynodesmus* in the structure of these teeth. Simpson, on the basis of more complete material, including the critical M_1, referred it to *Cynodesmus* under the name of *C. nobilis*. White placed *nobilis* in *Paradaphoenus* on the grounds that the entoconid and hypoconid of M_1 are of nearly equal size, whereas in *Cynodesmus thooïdes*, the type species of the genus, the entoconid is smaller than the hypoconid. However, *Paradaphoenus* possesses M^3 (Wortman and Matthew 1899, p. 129), which *iamonensis* does not, and for this and other reasons such an assignment is not possible. In the present state of our knowledge of the earlier Caninae, Simpson's reference to *Cynodesmus* is the only practicable one. Comparison of Thomas Farm material

[1] The type of *M. iamonensis* was first listed by Sellards as Florida Geological Survey no. 5082, later changed to V-319, and was then sent to the U. S. National Museum and given the permanent number, U.S.N.M. 8836.

TABLE 1

STATISTICAL DATA ON LINEAR DIMENSIONS OF PERMANENT TEETH OF TOMARCTUS CANAVUS

VARIATE		N	OR	M	σ	V
$P\frac{4}{}$	L	6	14.0—16.2	15.0± .34	.83± .23	5.5± 1.6
	W	6	7.0— 9.0	7.9± .32	.78± .22	9.8± 2.8
$M\frac{1}{}$	L	13	11.4—12.8	12.1± .13	.47± .09	3.9± .7
	W	13	13.8—15.2	14.3± .13	.46± .09	3.2± .6
$M\frac{2}{}$	L	6	7.0— 8.4	7.6± .20	.48± .14	6.3± 1.8
	W	6	11.2—14.0	12.3± .13	.33± .09	2.7± .7
$P\frac{}{2}$	L	6	6.9— 8.6	7.5± .32	.80± .23	10.6± 3.1
	W	6	3.4— 4.8	3.8± .21	.52± .15	13.6± 3.9
$P\frac{}{4}$	L	9	9.3— 11.8	10.5± .29	.86± .20	8.2± 1.9
	W	9	4.7— 5.6	5.1± .08	.26± .06	5.1± 1.2
$M\frac{}{1}$	L	13	16.3—18.5	17.0± .22	.81± .16	4.7± .9
	W	13	6.7— 8.3	7.3± .13	.47± .09	6.4± 1.3
$M\frac{}{2}$	L	7	9.1—10.2	9.6± .19	.50± .13	5.2± 1.4
	W	6	5.7— 6.9	6.2± .22	.53± .15	8.5± 2.5

TABLE 2

STATISTICAL DATA ON LINEAR DIMENSIONS OF PERMANENT TEETH OF CYNODESMUS IAMONENSIS

VARIATE		N	OR	M	σ	V
$P\frac{4}{}$	L	13	14.5—20.0	18.0± .04	1.52± .03	8.45± 1.66
	W	13	7.8—10.0	9.0± .08	.30± .06	3.20± .63
$M\frac{1}{}$	L	18	9.9—13.8	12.0± .21	.90± .15	7.50± 1.25
	W	18	12.2—15.5	14.5± .02	1.00± .02	6.88± 1.15
$M\frac{2}{}$	L	17	5.3— 7.8	6.8± .13	.56± .10	8.18± 1.40
	W	17	8.5—12.5	10.7± .02	1.03± .02	9.60± 1.65
$P\frac{}{4}$	L	10	10.9—12.8	12.0± .17	.55± .12	4.56± 1.02
	W	10	5.8— 6.8	6.5± .09	.30± .07	4.65± 1.03
$M\frac{}{1}$	L	13	18.3—21.2	20.0± .27	.97± .19	8.39± 1.65
	W	13	7.7— 8.9	8.4± .11	.42± .08	4.98± .98
$M\frac{}{2}$	L	8	9.6—10.7	9.9± .28	.80± .20	8.05± 2.01
	W	8	5.5— 6.9	6.1± .16	.46± .12	7.55± 1.69

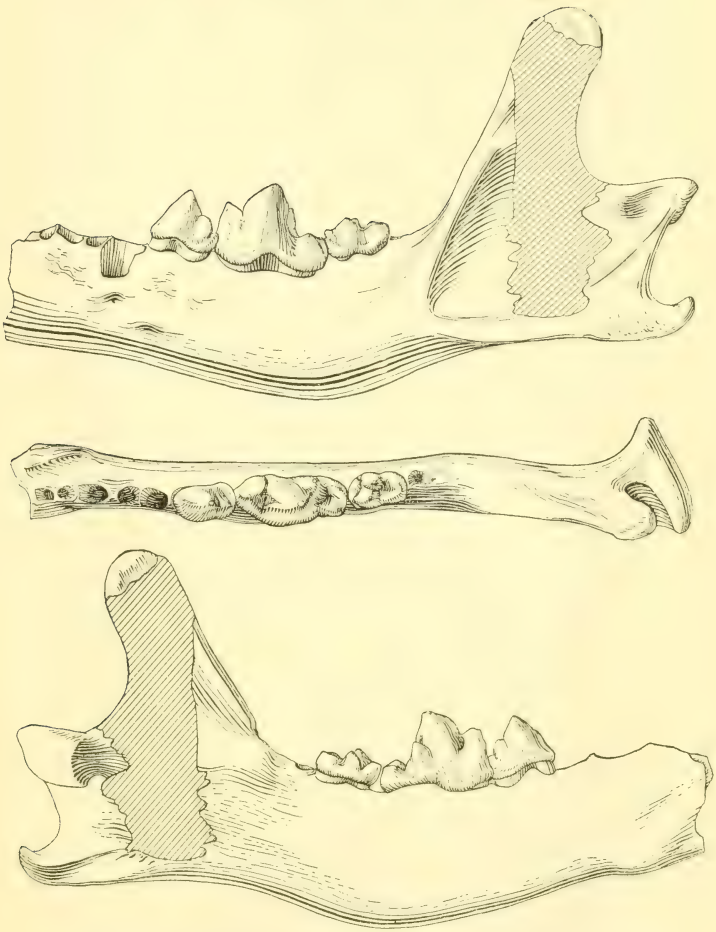

Figure 2. *Cynodesmus iamonensis*, labial, occlusal and lingual views. MCZ 3714. X 1.

with *C. thoöides* shows a close agreement in structure and proportions, I^3 is rather large relative to I^{1-2}, P^2 is rather large relative to P^3, and the heel of M_1 is basined. This last feature definitely rules out all possibility of reference to *Mesocyon*, in which M_1 has an unbasined talonid consisting of a large, bluntly pointed, anteroposteriorly elongate hypoconid and a low internal cingulum. With wear, the hypoconid in *Mesocyon* grinds out a circular area in the center of M^1, a feature not encountered in the *iamonensis* material.

C. iamonensis is readily distinguished from *C. thoöides;* $P\frac{2-3}{2-3}$ have lower, less pointed paracones, the protocone of P^4 is relatively smaller, the parastyle of M^1 smaller and less projecting, the hypocone of M^1 more expanded posteriorly and the anterior border of the posterior narial opening opposite M^2, rather than immediately posterior to M^2, as in *thoöides.* As White noted (1942, p. 6), the entoconid of M_1 is small in the type of *thoöides;* it is, in fact, subordinated in the internal cingulum, although this is raised to rim a definite basin. In *C. iamonensis* the entoconid of M_1 is usually distinct, but in M.C.Z. 3965 it is completely submerged in the cingulum, which is somewhat higher than, but otherwise identical to, that of the type of *thoöides.* Nothing need be added to Simpson's comparisons (1932, p. 18) with other species referred to *Cynodesmus.*

Simpson (1932, p. 19) regarded the Thomas Farm specimens as specifically distinct from *iamonensis* — the type of which is from the Griscom Plantation — on the basis of larger size, hypocone of P^4 more projecting internally, M^2 "relatively larger, more oblique, hypocone basin stronger and projecting more postero-internally." The present series shows that the difference in size is not significant and that M^2, in particular, is a highly variable tooth; specimens at hand connect Simpson's paratype of *nobilis* (F.G.S. V-5259) with the type of *iamonensis.* The geological evidence now available indicates that Griscom Plantation and Thomas Farm are of the same age. In 1930 (pp. 160-161, fig. 5) Simpson described some fragmentary canid material from the Franklin Phosphate Company mine as *Mesocyon iamonensis.* This may be referable to *Mesocyon* but certainly not to *iamonensis.* Simpson did not mention these fragments explicitly in his later paper, but they are obviously the basis for his record of

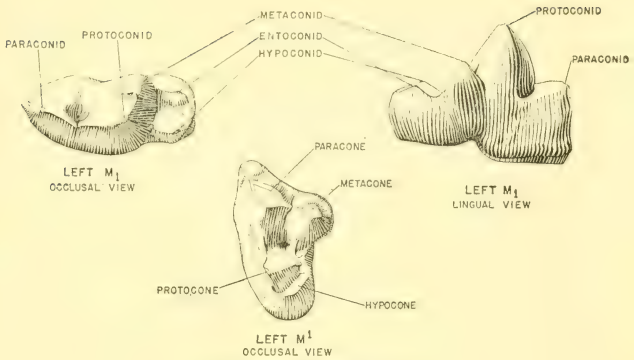

Figure 3. Tooth characters of *Cynodesmus iamonensis*. X 1½.

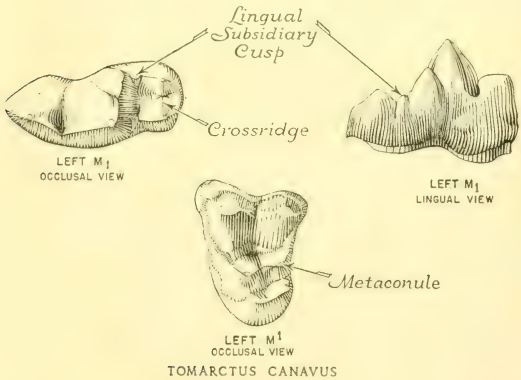

Figure 4. Tooth characters of *Tomarctus canavus*. Key characters indicated by arrows. X 1½.

? Temnocyon sp. from the Franklin Phosphate Company (1932, p. 14). No additional material representing this species has yet come to light.

Paradaphocnus tropicalis White was stated to be one-seventh smaller than *nobilis,* with the protocone and metacone of M^2 larger and the hypocone reduced. As regards size, analysis of the measurements shows no significant difference. M^2 is decidedly variable as to total size and also as to details of cusp proportion and structure; the differences mentioned by White disappear in the larger series.

The paratype of *Parictis bathygenus* White, a maxillary, is not morphologically distinguishable from *iamonensis,* and it is of interest in this connection that White noted a very close resemblance to *Mesocyon,* which as already remarked, is not unlike *Cynodesmus* in the structure of the posterior upper cheek teeth. A specimen referred to *Parictis* in the Chicago Natural History Museum, no. P-27157, shows conclusively that the Thomas Farm specimen has nothing to do with this group of canids.[1]

Cynodesmus iamonensis is a variable species, both as to size and as to details of dental structure, more so than *Tomarctus canavus.*

CONCLUDING REMARKS

It must be emphasized that this is a revision of the species present in the Thomas Farm deposit only. Whether or not these species are valid can be determined with certainty only by study of all material referable to the genera in question, a task beyond present opportunities. Nomenclature aside, it is possible to state with confidence that only two species of the Caninae are represented in the Thomas Farm deposit. It is curious that two true dogs very similar in size should have coexisted in nearly equal abundance. The differences in the structure of the posterior cheek teeth (cf. Figs. 3, 4) may have reflected some difference in habit, but this would at present be an uncertain inference. The available skulls are so crushed and poorly preserved that very little can be gained from them; the only impression received is that the face anterior to P^4 may have been a little longer in *C. iamonensis.*

[1] The type mandible is not referable to *Parictis* either, a point that will be taken up in a subsequent contribution.

Knowledge of the postcranial skeletons, however, may in the future reveal differences that cannot now be appreciated.

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TOMARCTUS CANAVUS

FIGURED SPECIMENS AND SYNONYMS	M_1 ANTEROPOSTERIOR DIAMETER	M_1 GREATEST TRANSVERSE DIAMETER	M_2 ANTEROPOSTERIOR DIAMETER	M_2 GREATEST TRANSVERSE DIAMETER
N. insularis MCZ 4507	16	7	--	--
C. canavus FGS V5260	16.5	7.5	9	6
C. canavus MCZ 3629	16.5	7	--	--
T. canavus MCZ 4333	17	7	10	5.5
T. canavus MCZ 4334	17	7.5	10	6.5
T. canavus MCZ 3924	17	7.5	--	--
T. canavus MCZ 3628	18	8	9	6.5
T. thomasi MCZ 3712	18	8.5	10	7.5

CYNODESMUS IAMONENSIS

C. nobilis MCZ 3633	19	7.5	95	5.5
C. nobilis MCZ 4521	19	8	9	6
P. tropicalis MCZ 3966	20	8	--	--
P. tropicalis MCZ 3965	20	8	9	5.5
P. tropicalis MCZ 3714	20	8	10	6
C. nobilis FGS V5255	20	8	10	6
P. nobilis MCZ 4330	21	8.5	11	7
P. nobilis MCZ 3724	21	8.5	--	--

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